OMB Number: 4040-0004
Expiration Date: 12/31/2022

Application for Federal Assistance SF-424

* 1. Type of Submission:
- [ ] Preapplication
- [x] Application
- [ ] Changed/Corrected Application

* 2. Type of Application:
- [x] New
- [ ] Continuation
- [ ] Revision

* If Revision, select appropriate letter(s):

* Other (Specify):

* 3. Date Received:

4. Applicant Identifier:

5a. Federal Entity Identifier:

5b. Federal Award Identifier:

State Use Only:

6. Date Received by State:

7. State Application Identifier:

8. APPLICANT INFORMATION:

* a. Legal Name: University of Wyoming

* b. Employer/Taxpayer Identification Number (EIN/TIN): 83-6000331

* c. Organizational DUNS: 0696909560000

d. Address:

* Street1: 1000 E. University Avenue, Dept. 3355
Street2:
* City: Laramie
County/Parish:
* State: WY: Wyoming
Province:
* Country: USA: UNITED STATES
* Zip / Postal Code: 82071-2000

e. Organizational Unit:

Department Name:

Division Name:

f. Name and contact information of person to be contacted on matters involving this application:

Prefix:
* First Name: Shauna
Middle Name:
* Last Name: Bury
Suffix:

Title: Assistant Director Research Services

Organizational Affiliation:

* Telephone Number: 307-766-5320
Fax Number:

* Email: shauna@uwyo.edu

Application for Federal Assistance SF-424

*** 9. Type of Applicant 1: Select Applicant Type:**

H: Public/State Controlled Institution of Higher Education

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

* Other (specify):

*** 10. Name of Federal Agency:**

United States Environmental Protection Agency

11. Catalog of Federal Domestic Assistance Number:

66.509

CFDA Title:

*** 12. Funding Opportunity Number:**

EPA-G2019-STAR-E1

* Title:

Contaminated Sites, Natural Disasters, Changing Environmental Conditions and Vulnerable Communities: Research to Build Resilience

13. Competition Identification Number:

Title:

14. Areas Affected by Project (Cities, Counties, States, etc.):

Add Attachment | Delete Attachment | View Attachment

*** 15. Descriptive Title of Applicant's Project:**

Predicting Drinking Water Contamination from Extreme Weather to Reduce Early Life Contaminant Exposures

Attach supporting documents as specified in agency instructions.

Add Attachments | Delete Attachments | View Attachments

Application for Federal Assistance SF-424

16. Congressional Districts Of:

* a. Applicant: WY-001 * b. Program/Project: WY-001

Attach an additional list of Program/Project Congressional Districts if needed.

Add Attachment | Delete Attachment | View Attachment

17. Proposed Project:

* a. Start Date: 10/01/2020 * b. End Date: 09/30/2023

18. Estimated Funding ($):

* a. Federal	799,952.00
* b. Applicant	0.00
* c. State	0.00
* d. Local	0.00
* e. Other	0.00
* f. Program Income	0.00
* g. TOTAL	799,952.00

*** 19. Is Application Subject to Review By State Under Executive Order 12372 Process?**

☐ a. This application was made available to the State under the Executive Order 12372 Process for review on .

☒ b. Program is subject to E.O. 12372 but has not been selected by the State for review.

☐ c. Program is not covered by E.O. 12372.

*** 20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes," provide explanation in attachment.)**

☐ Yes ☒ No

If "Yes", provide explanation and attach

Add Attachment | Delete Attachment | View Attachment

21. *By signing this application, I certify (1) to the statements contained in the list of certifications and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances** and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 218, Section 1001)**

☒ ** I AGREE

** The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

Authorized Representative:

Prefix: * First Name: Diana

Middle Name: G

* Last Name: Hulme

Suffix:

* Title: Associate Vice President for Research

* Telephone Number: 307-766-5320 Fax Number:

* Email: dhulme@uwyo.edu

* Signature of Authorized Representative:  * Date Signed: 09/10/2020

OMB Control No. 2030-0020 Approval expires 04/30/2021

U.S. ENVIRONMENTAL PROTECTION AGENCY
Washington, DC 20460

KEY CONTACTS FORM

Authorized Representative: *Original awards and amendments will be sent to this individual for review and acceptance, unless otherwise indicated.*

Name: Diana G. Hulme
Title: Associate Vice President for Research
Complete Address: 1000 E. University Avenue, Dept. 3355
Laramie, WY 82071-2000
Phone Number: 307-766-5320

Payee: *Individual authorized to accept payments.*

Name: Comfort Brownell
Title: Senior Director for Office of Sponsored Programs
Mail Address: 1000 E. University Avenue, Dept. 3355
Laramie, WY 82071-2000
Phone Number: 307-766-3750

Administrative Contact: *Individual from Sponsored Program Office to contact concerning administrative matters (i.e., indirect cost rate computation, rebudgeting requests etc.)*

Name: Shauna Bury
Title: Assistant Director of Research Services
Mailing Address: 1000 E. University Avenue, Dept. 3355
Laramie, WY 82071-2000
Phone Number: 307-766-5320
FAX Number:
E-Mail Address: shauna@uwyo.edu

Principal Investigator: *Individual responsible for the technical completion of the proposed work.*

Name: Jacob Hochard
Title: Knobloch Assistant Professor of Conservation Economics
Mailing Address: Haub School of Environmental and Natural Resources
1000 /E. University Avenue, Laramie, WY 82071-2000
Phone Number: 307-766-5080
FAX Number:
E-Mail Address: jhochard@uwyo.edu
Web URL: http://www.uwyo.edu/haub/

a. **Funding Opportunity:** Contaminated Sites, Natural Disasters, Changing Environmental Conditions and Vulnerable Communities: Research to Build Resilience. (G2019-STAR-E.1)

b. **Project Title:** "Predicting Drinking Water Contamination from Extreme Weather to Reduce Early Life Contaminant Exposures"

c. **Investigators:** Lead PI: Jacob P. Hochard[1], Co PIs: Kayla Clark, David Collier, Scott Curtis, Randall Etheridge, Jamie Kruse, Ariane Peralta, PI contact: JHochard@uwyo.edu

d. **Institutions:** U. of Wyoming (lead), Laramie, WY, East Carolina University, The Citadel

e. **Project Period and Location:** October 2020-September 2023; North Carolina

Project Cost: $800,000	FY 20-21	FY 21-22	FY 22-23	Total
Total Direct Costs	$228,232	$224,894	$232,520	$685,646
F&A (Indirect Costs)	$ 49,820	$ 33,811	$ 30,675	$114,306
Total Requested from Sponsor	$278,052	$258,705	$263,195	$799,952

f. **Project Summary:** Private wells are the drinking water source for over 43 million U.S. households but remain unregulated federally and are vulnerable to contamination from environmental hazards. Over 2 million North Carolina residents use wells in areas prone to hurricanes and floods, which can increase chemical and biological contamination (e.g., pathogenic bacteria) . Households near contaminated sites, such as animal feeding operations, hazardous waste and coal ash facilities are especially vulnerable to upgradient contaminants, which can be intensified by air temperature and precipitation trends. No mechanism exists for predicting contamination events and informing a cost-effective and human health-preserving intervention. Yet, large-scale and fine-resolution datasets, from federal, state and local agencies, have the potential to capture the complex human and physico-chemical interactions that predict contamination. Developing novel quantitative approaches that synthesize large and disparate data sets is critical to guiding interventions that could be used by local health offices to prevent early life exposures that impair cognitive development.

(1) Objectives. We propose a multidisciplinary (atmospheric science, economics, ecological engineering, design, pediatrics, microbiology, soil ecology) approach to **(1) predict groundwater contamination that leads to human exposures, (2) based on predictive models, engage with county health offices to notify at-risk households with a newborn and (3) assess the impact of the risk messenger on risk mitigation choices.** We hypothesize: (1a) chemical concentrations and coliform bacteria in wells relates to proximity to contaminated sites during precipitation events, (1b) bacterial contamination depends on source and seasonality, (1c) homes with aging wells are more vulnerable to contaminants, (3) risk communication from an ECU pediatrician promotes households' risk mitigation behaviors.

(2) Experimental Approach. We will synthesize soil, hydrological, meteorological and built infrastructure data alongside a statewide database of private well testing to predict contamination events using econometric and machine learning techniques. Households with a birth in the current year's vital statistics, that are likely to have a contaminated well, will receive an alert and option for water testing from their county health office. The messenger of the alert will be assigned randomly as an ECU pediatrician or a county health official. Findings from new water tests will be used to groundtruth and improve the model's predictive capacity.

(3) Expected Results. Our research will (i) identify households most likely to be exposed and vulnerable to chemical and biological contaminants during severe weather, (ii) prevent impairments to cognitive development of newborns and (iii) evaluate the effectiveness of local public health offices partnering with university medical clinicians to communicate health risks.

(4) Supplemental Keywords: Community-based risk management, averting behavior.

1. Objectives

OVERVIEW

Rural communities are among the most vulnerable to natural disasters because of lack of social and public works infrastructure. Rural residences often experience disruptions to health care services (Hoard et al. 2005, Manley et al. 2006, Baack and Alfred 2013, Witt and Menegat 2019), the failure of existing public infrastructure, such as electrical utilities (Miller et al. 2018), the absence of centralized infrastructure that creates a dependence on septic (Mallin and Corbett 2006, Schneeberger et al. 2015), and reliance on private well (Eccles et al. 2013, Andrade et al. 2018) systems prone to failure and contamination from flooding. The impacts of such disasters on human health in rural, underserved communities remains poorly understood because sparsely populated areas are the most difficult to monitor for pollution events (Charrois 2010, Canter 2019) and human health trends (Moscovice et al. 2000, Bolin et al. 2015). However, these areas also tend to be the locations where pollution sources, such as industrial and agricultural operations, hazardous waste sites and coal ash facilities, agglomerate. Modern monitoring of environmental exposures near contaminated sites requires scalable data-driven approaches that (i) predict, with a high level of accuracy, contamination and exposure events (Hino et al. 2018), (ii) reduce the financial cost of highly-targeted and local human health-preserving interventions in the most vulnerable rural communities (Larsson et al. 2018) and (iii) increase the effectiveness of risk communication in areas that are often distrusting of county and state officials (De Wit et al. 2018, Fizer et al. 2018).

The research team's ongoing work, funded by the U.S. EPA Science to Achieve Results (STAR) program (PIs Hochard, Etheridge and Peralta) and the U.S. EPA Office of the Resource Conservation and Recovery Act (PI Hochard), assesses the impacts of concentrated animal feeding operations (CAFOs), coal ash facilities and hazardous waste sites on historical North Carolina birth outcomes vis-à-vis *in utero* exposure to contaminated groundwater. North Carolina has the second largest population nationally relying on private well systems for drinking water, is among the nation's leaders in animal agriculture production and recently experienced the third-worst coal ash spill in US history. The team's existing collection of historical large-scale and statewide groundwater quality, natural hazards and human health outcomes data, and near known contaminated sites, represents a unique research opportunity to develop and implement the first statewide remote and predictive monitoring system of groundwater contamination. This statewide system will be used in a state-county-university partnership to prevent residence-level early life exposures to waterborne contaminants.

We propose a multidisciplinary (atmospheric science, economics, ecological engineering, pediatrics, microbiology, and soil ecology) to (1) predict groundwater contamination that leads to human exposures, (2) based on predictive models, engage with county health offices to notify at-risk households with a newborn and (3) assess the impact of the risk messenger on risk mitigation choices. We hypothesize: (1a) chemical concentrations and coliform bacteria in wells relates to proximity to contaminated sites during precipitation events, (1b) bacterial contamination depends on source and seasonality, (1c) homes with aging wells are more vulnerable to contaminants, (3) risk communication from an ECU pediatrician promotes households' risk mitigation behaviors.

Often, state-level monitoring of environmental and human health factors are siloed among agencies and vary in spatial and temporal resolution. Large and disparate, but publicly-available, datasets such as built structure specifications, neighborhood boundaries, local soil properties, private well water testing results, demographic and tax information, public infrastructure, rainfall, temperature and known locations of contaminated sites require novel and creative methods to

combine. Our team will develop a computational prediction of well contamination risk that can be used by East Carolina University (ECU) to (i) monitor time-varying and time-invariant atmospheric, geological, ecological, and human social and built conditions that determine well contamination and (ii) leverage ECU's institutional prowess and employed physicians in the region to communicate health risks. As an established, community partner, ECU-supported programs have demonstrated success in community engagement programs that builds trust relative to the well-documented distrust that has been associated with health risk messaging from local or state health officials.

Mapping this landscape of risk, in response to severe weather and in proximity to contaminated sites, will enable highly-targeted interventions by rural county health offices. Rural county health offices tend to be understaffed and lacking the financial resources required to monitor private well water quality and assess public health risks throughout their jurisdictions. This regional university-county partnership will be enriched with state-level partners, such as the Department of Health and Human Services Vital Statistics Division, to identify households that are not only at-risk of exposure but are also most vulnerable to exposure because a newborn resides in the home.

Together, this data-driven approach to large-scale environmental monitoring and university-local government-state government partnership has the potential to transform the surveillance of public health risks in rural areas that have been historically financially infeasible to monitor. Such an approach would be generalizable to other states that have statewide data collection efforts, strong regional university systems and a large population depending on private wells that are underserved by infrastructure and healthcare services, such as Pennsylvania, Indiana and Texas.

EXPANSION ON EXISTING EPA STAR AWARD (RD836942)

PIs Hochard, Etheridge and Peralta are currently investigating the role of natural capital in buffering households downstream of concentrated animal feeding operations (CAFOs) in six rural eastern North Carolina counties. The study area is highly dependent on private wells for drinking water and contains the country's densest animal agriculture industry. In this setting, animal waste storage and application to nearby spray fields risks running off into surface and groundwater and contaminating the drinking water sources for nearby communities. The objectives of the ongoing work are the following: **(i) identify and measure the effect of swine production operations on local human health, (ii) examine if land cover, soil types, hydrographic relationships and public institutions mediate health outcomes and (iii) construct neighborhood-specific recommendations to inform community-level management of human health risks.**

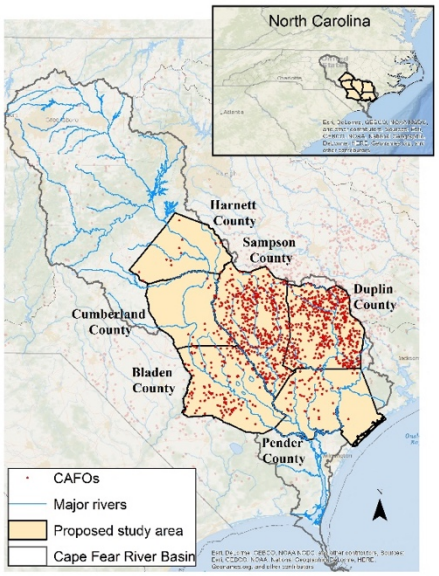

Figure 1. Map of existing study area in eastern North Carolina

Preliminary results indicate an increased risk of fecal coliform bacteria and nitrate contamination of private wells that are hydrologically downstream of CAFOs. However, this risk appears to be self-mediated by the decision of households near CAFOs to drill deeper wells – i.e., put more soil between their drinking water source and a potential source of contamination

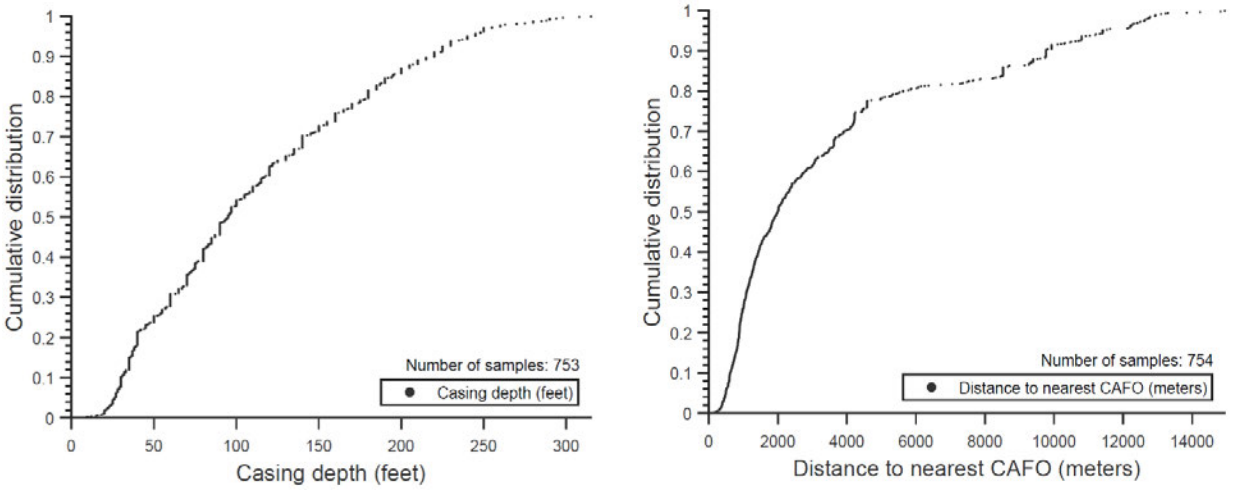

Figure 2. Distributions of casing depth (ft) of private wells and the distance to nearest CAFOs (m).

(Figure 2). Such "avoidance behavior" in our study area often goes undocumented because of the unregulated nature of private wells. We estimate that proximity to swine and poultry CAFOs explains as much as $1.5 million per annum in the cost of drilling deeper groundwater wells to avoid exposure. We also find that (i) poorer households that tends to be located near CAFOs are less able to make these investments in "deep" wells and remain disproportionately vulnerable to ingesting contaminated groundwater and that (ii) soils with particularly high filtering properties provide additional protection of groundwater from nearby contaminant sources thus reducing the likelihoods of a contamination event and reducing the cost of avoiding such an event. These results highlight the joint natural-human nature of exposure to waterborne contaminants and how indicators such as household income, year of home construction, soil properties and precipitation trends may be informative in predicting highly local groundwater contamination near industrial and agricultural sites across a large scale.

The research team also used a fully randomized control trial to assess the impact of communicating local risks of water contamination to nearby households. Here, we are monitoring the North Carolina State Laboratory's testing of all new wells and selected all nearby households within 1-mile of a new wells that tested positive for total coliform into an

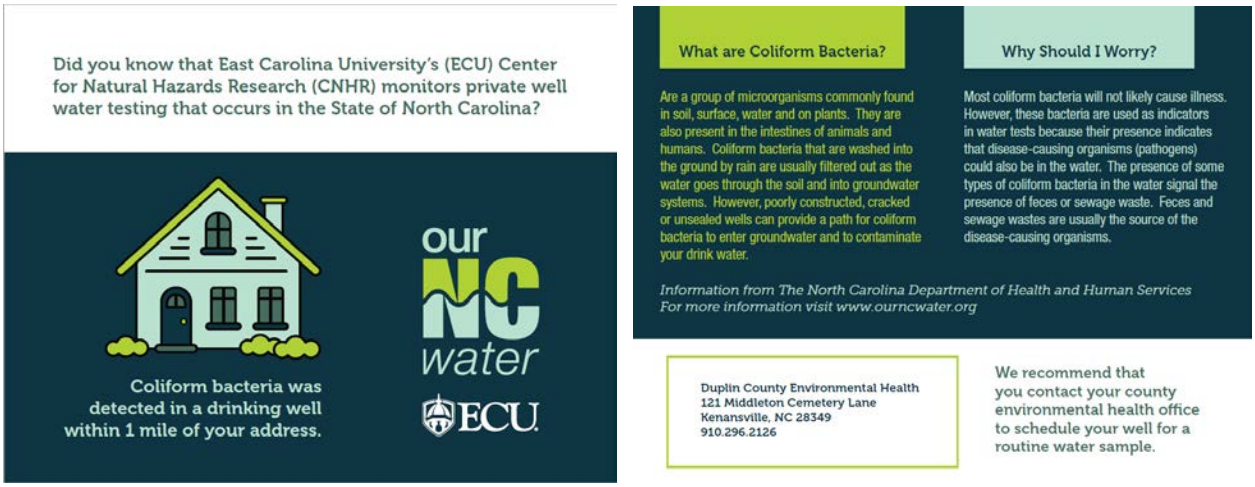

Figure 3. Ongoing randomized control trial of communicating risk information in a pilot private well water alert system.

experimental design. A baseline group of households was not contacted. Households were then randomly assigned into 4 treatment groups that received postcard notifications that a private well that was (i) recently tested within 1-mile of their home, (ii) recently tested within 5-miles of their home, (iii) nearby their home and tested within the past 7 days or (iv) nearby their home and tested within the past 30 days was found to have total coliform bacteria present. Associated information pertaining to the human health risk presented by total coliform in well water was included along with directions for testing their own well were included. Volunteer testing by these households, through their local county health offices, were then monitored. Currently, we have notified over 2,500 households and have increased private well testing in these communities by approximately 50%. As the experiment continues, we expect to evaluate the relative influence of "recency of exposure" and "proximity to exposure" as a policy nudge of homeowners to test voluntarily their water, which could be used to inform a cost-effective statewide private well alert system.

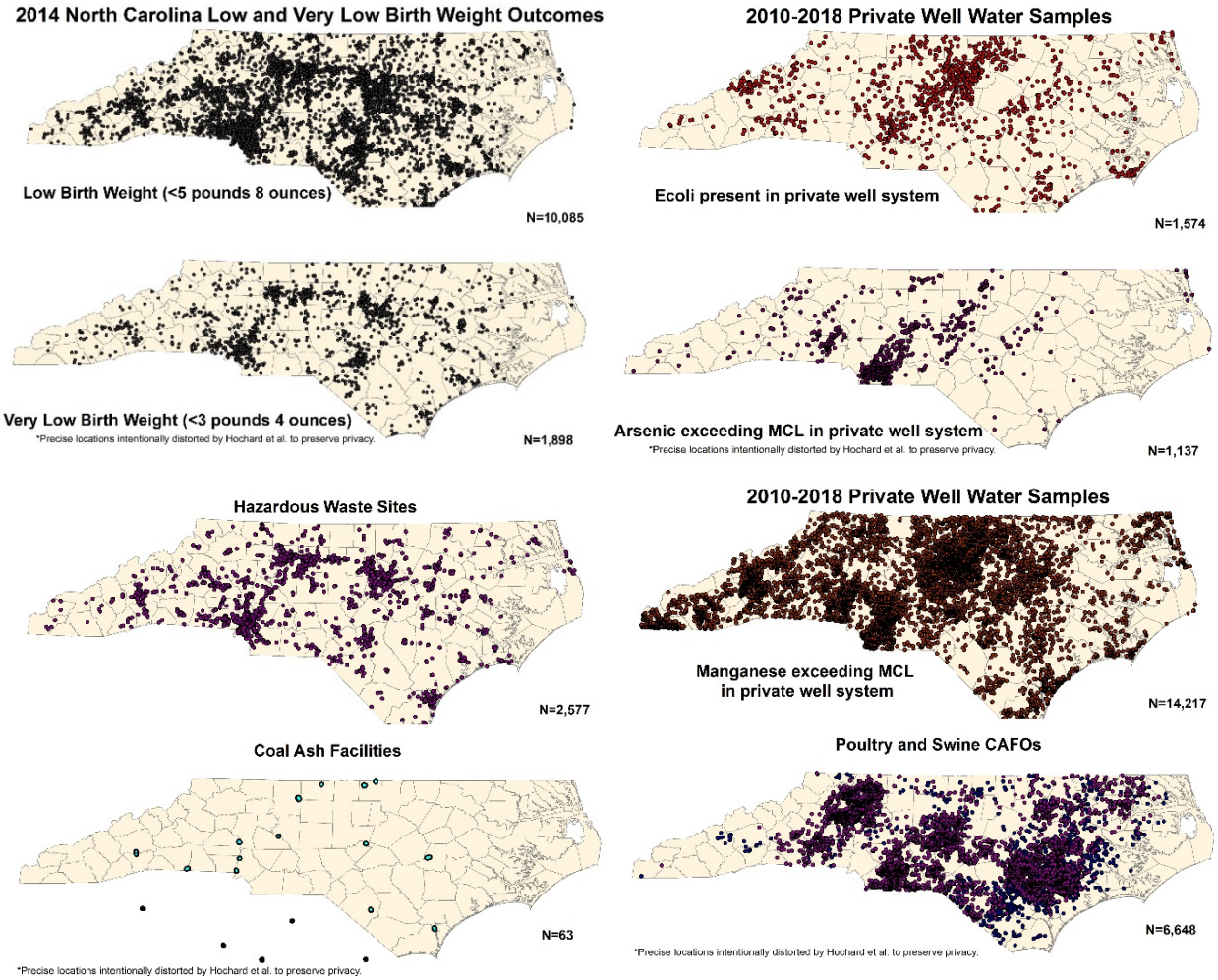

Figure 4. Ongoing statewide mapping of various human health outcomes, private well water samples and contamination sites.

Table 1 Taxonomy of existing database from US EPA awards (1. Early life human health outcomes, 2. Contaminated sites, 3. Historical groundwater pollution indicators).

Variable	*Coverage*	*Temporal resolution*	*Spatial resolution*	*Source*
(i) Early Life Human Health Outcomes and Mediating Risk Factors *(Existing ECU IRB #17-000354)*				
Birth weight (lbs, oz) **Gestation length (weeks)** **Date of mother's last live birth** **Birth hospital** **Travel distance to birth hospital and available alternatives** **Number of prenatal care visits** **Month in which prenatal care began**	Statewide, Approx 2.6 million births	1996-present	Residential Address	NC Department of Health and Human Statistics Vital Statistics Office
Mother's medical risk factors: *(Anemia, Cardiac Disease, Acute and chronic lung disease, Diabetes, Genital herpes, Hydramnios Hemoglobinopathy, Chronic and Pregnancy-Related Hypertension, Eclampsia, Incompetent Cervix, Previous Infant 4000+ Grams, Previous Preterm or Small-for-Gestational Age Infant, Renal Disease, Rh Sensitization, Uterine Bleeding)*				
Congenital anomalies of newborn: *(Anencephalus, Spina Bifida, Hydrocephalus, Microcephalus, Central Nervous System Anomalies, Heart Malformations, Circulatory/respiratory Anomalies, Rectal Atresia, Tracheo-esophageal Fistula, Omphalocele/Gastroschisis, Other Gastrointestinal Anomalies, Malformed Genitalia, Renal Agenesis, Urogenital Anomalies, Cleft Lip/Palate, Polydactyly/Syndactyl/Adactyl, Club foot, Diaphragmatic Hernia, Musculoskeletal Anomalies, Down's Syndrome)*				
(ii) Contaminated Sites				
Swine CAFOs	4,148 sites	1996-Present	Coordinates	NC DEQ
Poultry CAFOs	3,969 sites	1996-Present	Coordinates	EWG
Coal Ash Facilities	15 facilities/63 impoundments (33/63 active)	1949-Present	Coordinates	EPA RCRA
(iii) Historical Groundwater Pollution Indicators				
Private Well Samples				
Microbiology: (*Total Coliform and E. Coli)*	77,490 statewide samples	2008-Present	Residential Address	NC DHHS State Laboratory
Inorganic chemicals: (*Arsenic, Barium, Cadmium, Calcium, Chloride, Chromium, Copper, Fluoride, Iron, Lead, Magnesium, Mercury, Nitrate, Nitrite, pH, Selenium, Silver, Sodium, Sulfate, Total Alkalinity, Total Hardness, Zinc)*	104,651 statewide samples	2008-Present	Residential Address	NC DHHS State Laboratory

Consistent statewide hydrological modeling is an essential component of constructing a risk prediction model. In our existing word, we have built a generalized solute transport model (STM), adapted from the Terrain Analysis Using Digital Elevation Models (TauDEM toolbox), which links hydrologically residences with nearby swine and poultry CAFOs. A pour point is then constructed for each residential address and used to create an upstream drainage basin that proxies

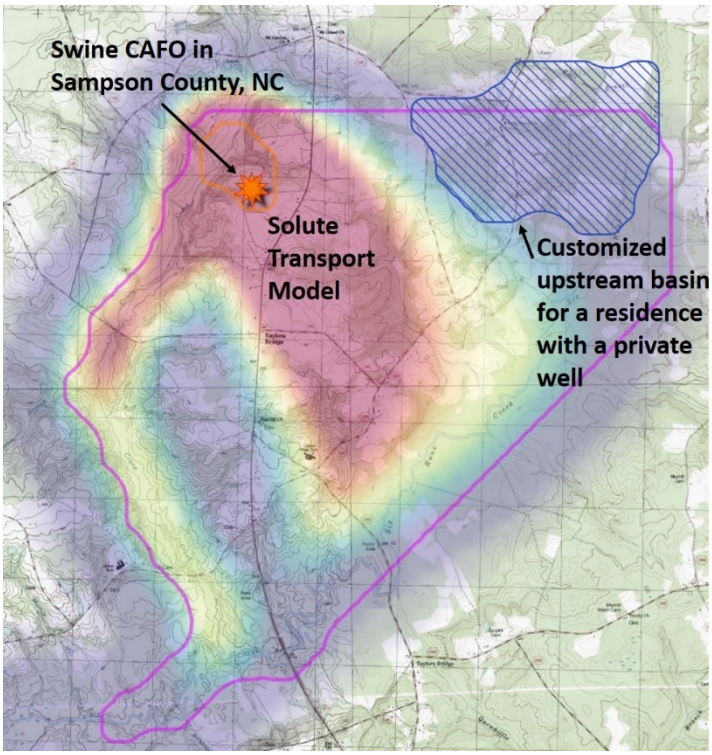

Figure 5. Customized hydrological model for North Carolina to link specific contaminated sites with downstream residential addresses.

for the upgradient extent that may influence a household's groundwater source. Empirically, we have constructed 3 measures of exposure: (1) a direct intersection between a contaminated site's STM and a residential address' primary built structure, (2) a direct intersection between a contaminated site and the upstream basin of the residential address' built structure and (3) a intersection between the STM and the upstream basin (show in Figure 5). Employing a variety of "exposure" definitions is important because surface water flow is only a proxy for groundwater flow.

BACKGROUND

Implications of early life ingestion of contaminated well water: Early life exposure (within the first 5 years of life) to inorganic chemicals in drinking water can have immediate and long-lasting impacts on human health and cognitive development. For example, *in utero* and early childhood exposure to inorganic arsenic in drinking water is associated with the formation of malignant and non-malignant lung disease in young adults (Vahter 2008). Early life exposure to cadmium and manganese have also been associated with impaired cognition while manganese is also associated with behavioral effects (Sanders et al. 2015). The risk of infant methemoglobinemia, also known as "Blue Baby Syndrome", increases with prenatal and early childhood exposure to nitrate-contaminated drinking water (Knobeloch et al. 2000), which, if left untreated can lead to coma and death. Colorectal cancer, thyroid disease and neural tube defects have also been associated with high levels of nitrates in drinking water (Ward et al. 2018).

Bacteria and viruses in drinking water are also known to cause gastrointestinal illnesses, such as a diarrhea, in children, which can lead to dehydration (Postma et al. 2011). MacDonald Gibson and Pieper (2017) show that "99% of N.C. emergency-department hospital visits for acute gastrointestinal illnesses are associated with waterborne microbial contaminants that is attribute to private-well contamination". Despite approximately 29% of North Carolina private wells testing positive for total coliform (Stillo and Macdonald Gibson 2016), a well-known indicator that the drinking water system might be susceptible to contamination, less than 1 out of 3 households with children under the age of 7 had ever tested their well water for contamination (Postma et al. 2011). In majority Black periurban neighborhoods, rates of *Escherichia coli* contamination of private wells exceeded 6% in Wake County, North Carolina increasing the risk of acute gastrointestinal illnesses. The likelihood of a household testing their private well system for contamination and taking mitigative action is known to increase with education, income and

ownership status (Postma et al. 2011), which suggests households with children most vulnerable to harmful environmental exposures – i.e., those without health insurance – might also be the most likely to experience such exposures.

Known contaminated sites and contaminants in North Carolina:

Pollution from human activities is pervasive and continues to threaten environmental and human health. Together, industrial pollution due to manufacturing and agricultural as well as human waste management contribute to reducing water quality in rural and urban areas. Known heavy metals and other organic-based chemical contaminants are known contaminants to ground and surface waters. For example, in a study of 71 landfills in North Carolina, chromium, lead, zinc, cadmium and arsenic were the most common heavy metals associated with downstream ground and surface waters (Borden and Yanoschak 1990). Other known contaminants, such as per- and polyfluoroalkyl substances (PFASs), are also threatening water resources. These substances are from producing plastics, water/stain repellents, firefighting foams, and food-contact paper coatings (Sun et al. 2016). PFASs get into drinking water from upstream sources such as industrial sites, military fire training areas, civilian airports, and wastewater treatment plants (Sun et al. 2016, Hu et al. 2016). Also, coal combustion residue that discharges from settling ponds are documented to threaten water quality of downstream waters in North Carolina as well (Ruhl et al. 2012). In addition to established and emerging industrial contaminants, concentrated animal feeding operations are well-documented sources of nitrogen, phosphorus, and fecal coliform bacteria (Harden et al. 2015, Heaney et al. 2015, Mallin and Calhoun 2003, Mallin et al. 2015). Emerging biological contaminants associated with antibiotic resistance are also associated with swine and human waste contamination (Glassmeyer et al. 2005, West et al. 2011)

Contaminated site breaches from severe weather: Infrastructure that transport contaminants or impoundments containing concentrated contaminants that are constructed and managed following all regulations are susceptible to leaking, overflow, or breaching. Improper construction or management only increase this risk. Extreme weather events present a time when the storage impoundments and other infrastructure are stressed beyond normal levels and are more at-risk for failure. For example, Hurricane Floyd (1999) and Hurricane Matthew (2015) were both preceded in eastern North Carolina by large rainfall events. This kept swine producers from applying waste to their spray fields and resulted in elevated waste levels in swine lagoons prior to these hurricanes. The elevated waste levels contributed to the overflow or failure of waste lagoons following the hurricanes. As a result of Hurricane Floyd, 46 animal operations had either been inundated by floodwaters or had breached lagoons (Wing et al., 2002).

The release of contaminants is not limited to swine lagoons. Coal ash impoundments, septic systems, and wastewater treatment facilities can also be sources of contaminants to both surface water and groundwater (Mallin and Corbett, 2006; O'Driscoll et al., 2014). Wastewater treatment plants are often sited at lower elevation near rivers to maximize the use of gravity for delivery of waste to the plant and to position the plant for discharge of treated effluent to the river. This makes them highly susceptible to flooding. The Greenville, NC wastewater treatment plant serves as an example as much of the plant was underwater during Hurricane Floyd (Bales et al., 2000). Treatment plants that are not flooded still often must release partially treated or untreated waste due to power failures during tropical storm events (Mallin et al., 1999). The February 2014 Dan River coal ash spill illustrates that substantial amounts of contaminants can be released under non-tropical storm conditions. The release of 39,000 tons of ash and 27 million gallons of ash pond water contaminated was the result of a pipe failure. This release led to contaminants

including arsenic, copper, and lead being found in waters many miles downstream of the storage pond (USGS, 2019).

Historical responses to contaminated site breach events: When a known contamination breach occurs, federal and state funds are often provided to offset the financial cost of private well testing to track contamination rates and mitigate potentially harmful environmental exposures. Such post-hurricane testing, for example, often reveals spikes in *E. coli* presence in wells. Following Hurricane Florence, our database revealed that approximately 15% of wells tested positive for *E. coli*, which generally occurs at a rate of 2% statewide. In 2018, following Hurricanes Florence and Michael, the National Groundwater Association reported that over 600,000 private wells were potentially affected by recent Atlantic hurricanes of which over half were in North Carolina. Further, our database reveals that less than 2% of such North Carolina private wells are tested in any given year and that wells receiving testing are unlikely to be representative of the broader North Carolina population. Thus, the routinely tested private wells are likely to underrepresent populations that are especially vulnerable to waterborne pathogens and chemicals.

The leaking of unlined coal ash impoundments is unlikely to elicit a pointed risk management response because of the long timeline necessary to document contamination across space and time (Harkness et al. 2016). Suspected leaking may also lead to US EPA suggestions for additional monitoring and studies, but these often take years to complete. For example, The US EPA encouraging further monitoring of Duke Energy's facilities for potential coal ash contamination of the Dan River in 2009 (Walker and Loucks 2015). It was later revealed that the firm's emergency action plan was incomplete, and it was not until a major spill occurred in 2014 that major mitigative (e.g. bottled water distribution, broad private well sampling) actions were taken (Walker and Loucks 2015). The 2014 event generated an economic cost of $295 million of which $75 million was attributed to human health impacts (Lemly 2015).

Big data techniques to predict well contamination: Hino et al. (2018) suggested that public agencies might benefit from monitoring and enforcing environmental regulations using data-driven approaches to improve use of limited resources. Similar proposals have been offered for the development of early warning systems (EWS). For example, machine learning techniques have been deployed to assess flood vulnerability risks where an artificial intelligence component – i.e., the construction of neural clouds, was developed to recognize abnormal dike behavior. Likewise, probabilistic neural networks (PNN) and econometric estimators -i.e., multiple logistic regression models - have been used to predict the structural integrity of storm-water pipes (Tran et al. 2009). SAFEWATER was a tool developed to predict drinking water contamination events that combined the installation of remote sensors and machine learning methods that detect contamination events following major disasters (Bernard et al. 2015). The design, which is innovative but common in urban areas, served by centralized public water infrastructure, aims to efficiently manage potential water contamination crises. To our team's knowledge, no effort has been developed to autonomously monitor private – i.e., decentralized – well water systems and use predicted risk levels to launch a human health-preserving intervention. North Carolina's extensive database of private well samples presents a unique opportunity to predict water contamination risks in rural areas that are often underserved by access to such public services.

Risk communication among vulnerable households: Governmental distrust has been a longstanding challenge to the management of groundwater contamination risk (Fitchen 1987) and other environmental resources (Lowery et al. 1983, Stoffle et al. 1983). Regarding public

health concerns, rural areas have been associated with low levels of social capital known to decrease trust in communities (Numella et al. 2008), which is especially true regarding the trust of non-local government authorities (Wray et al. 2006). Stone et al. (2017) show that in North Carolina, professionally designed risk communication material increases the trust (presumably from an increased perception of competence) of risk managers in rural settings. Despite recent concerns, the public trust of physicians as a group has remained quite high in their role as human health risk messengers (Blendon et al. 2014). Together, professionally designed outreach material, a qualified medical clinician as the risk messenger and the sponsorship of a regional university, which tend to have strong social networks and shared norms in a society (Allison and Eversole 2008), may improve the effect of risk communication to rural households dependent on federally-unregulated private well water systems.

OVERARCHING QUESTION: How can the cognitive development and intellectual potential of children be improved by using big data prediction techniques that detect private well water contamination events in rural, underserved locations?

GENERAL HYPOTHESES: The below hypotheses of the proposed research are numbered to correspond with their associated research objective.

Hypothesis 1a: Chemical concentrations and coliform bacteria in wells relates to proximity to contaminated sites during precipitation events. We expect that periods of sustained rainfall are related to increased levels of nonpoint source pollutants such as E. coli, nutrient (e.g. nitrogen, phosphorus) and organic chemicals such as pesticides and fertilizers. We also expect that sustained rainfall increases the likelihood of a contaminated source breach or runoff from unlined impoundments into surface and ground water.

Hypothesis 1b: Bacterial contamination depends on upgradient source and seasonality. We expect that bacterial contamination of wells will most likely among households in near proximity to concentrated animal feeding operations (AFOs) and during warm weather that promotes bacterial growth.

Hypothesis 1c: Homes with aging wells are more vulnerable to contaminants. We expect that private wells in older homes (e.g. 30 to 50 years) are more vulnerable to contamination. While no database exists documenting well construction years, we expect these to be highly correlated the built year of the structure for homes <50 years old.

Hypothesis 3: Risk communication from an ECU pediatrician promotes households' risk mitigation behaviors. We expect that notifying households with a newborn of potential contamination risk will encourage those households to contact their county health office and schedule a free water testing. However, we expect disproportionately more households will schedule such a testing when the risk notification is delivered from an ECU pediatrician rather than the local county health office.

RESEARCH OBEJCTIVES: The objectives of the proposed work are to (1) predict groundwater contamination that leads to human exposures, (2) based on predictive models, engage with county health offices to notify at-risk households with a newborn and (3) assess the impact of the risk messenger on risk mitigation choices.

To test the above hypotheses, we will synthesize a variety of statewide and publicly available datasets from local, county, state and federal sources. Together, these sources will capture the complex and interacting atmospheric, geological, ecological, and human social and built systems that determine the landscape of groundwater contamination and exposure risk. We will analyze these data using a variety of machine learning and econometric estimation techniques designed to predict private well contamination based on time-varying and time-invariant factors. The

proposed estimation strategy will avoid imposing structural restrictions on any of the interacting systems and will instead adopt a data-driven approach that maximizes the model's predictive capacity. Accurate prediction of private well contamination risk will then be used in a collaborative effort between a professional graphic designer and risk communicator, an ECU pediatrician and North Carolina's county health offices, which are overseen by the North Carolina Department of Health and Human Services On-Site Water Protection Branch. A data-driven approach to groundwater contamination monitoring that informs county-driven interventions has the potential to transform the way environmental monitoring occurs in rural areas that have remained underserved because of sparse populations and limited resources necessary to support broad sampling and outreach.

Approach and activities

Hydrological Modeling: Under EPA RD836942, a statewide hydrological model has been constructed that links any two points in North Carolina hydrologically. This hydrological model is adapted from Terrain Analysis Using Digital Elevation Model (TauDEM) tools and is based on a solute transport model (STM) overlaid on contaminated sites and customized upstream basins constructed for residential addresses. The proposed work will generalize this model to all contaminate sites in North Carolina (Table 2). Further, because surface water modeling is a proxy for groundwater flow, we will further enhance our warning system and to allow for testing of management strategies to reduce risk, we will couple the watershed-scale SWAT+ model (Bieger et al., 2017) with the groundwater model MODFLOW (Hughes et al., 2017). The SWAT+ model simulates water and contaminant transport at or near the surface. MODFLOW combined with the solute transport simulator MT3D-USGS (Bedekar et al., 2016) simulates water and contaminant transport in the groundwater aquifers. Coupling SWAT+ with MODFLOW will allow us to simulate the transport of contaminants from their source at the

TEAM MEMBERS + ROLES

✕	**Risk + Econometric Analysis** Jacob Hochard *Department of Economics, Coastal Studies Institute* Jamie Kruse *Center for Natural Hazards Research, Dept. of Economics*
●	**Hydrological Modeling** Ariane Peralta *Department of Biology, Water Resources Center* Randall Etheridge *Department of Engineering, Water Resources Center*
~	**Atmospheric Modeling** Scott Curtis *Department of Geography, Planning & the Environment*
✚	**Pediatric Health** David Collier, MD *Department of Pediatrics, Brody School of Medicine*
▲	**Communications Design** Kayla Clark *School of Art & Design, College of Fine Arts & Communication*

SELECT DATASETS

Vital Statistics	**Public Infrastructure**	**Soil**
Built Structures	**Contaminated Sites** Coal Ash CAFOS: Swine + Poultry Hazardous Waste	**Weather** Temperature Rainfall Flooding
Hydrological Flow		
Geological Formations		

APPROACH

team	year	
		PREDICTION
✕ ● ~	1–3	**Statewide Econometric + Machine Learning Analysis** Identify specific households with: Children aged 0–5 years old High-risk of well contamination
		DESIGN
✚ ▲	1	**Design of Notification** Notification Development with stakeholders: ECU Brody School of Medicine NC DHHS (Wilson Mize)
		COMMUNICATION
✚ ▲	1–3	**Randomized Selection of Risk Messenger** Notifications sent from: ECU Pediatrician County health offices
		INTERVENTION
✕ ●	1–3	**Provide Free Water Testing to Respondents** Use existing county water-sampling resources
		VALIDATION
✕	2–3	**Compare Predicted + Actual Water Quality** Revise prediction and repeat approach

Figure 6: Conceptual layout of approach to proposed work and team members' areas of expertise.

surface to the wells that are the source of drinking water (Bailey et al., 2016). Creating a coupled SWAT+MODFLOW model for all of North Carolina is outside the scope of this project. For this project, we will calibrate and validate the coupled model for the Cape Fear River watershed in North Carolina. The Cape Fear River watershed was chosen because it is the location of our current groundwater contamination projects, which reduces the amount the data collection required to begin running the model. If calibration and validation is successful in this watershed and the coupled hydrological model enhances our warning system, the model can be expanded to other areas in the future.

We will use existing monitoring data and information from a previously calibrated MODFLOW model of the area to begin calibration and validation (Coes et al, 2016). The flow and water quality parameters in the SWAT+ model will be calibrated using flow data from the USGS gauge stations in the watershed and using water quality data from the NC Department of Environmental Quality Ambient Monitoring System. Coes and others (2016) led an effort to calibrate and validate a MODFLOW model in portions of North Carolina, South Carolina, Georgia, and Virginia. The data and model parameters developed from the effort by Coes and others will be updated and used for this project. Updated water level data will come from the NC Department of Environmental Quality Division of Water Resources groundwater monitoring network. Data from our previous projects on contaminant sources and groundwater quality will be used for calibrating and validating the groundwater solute transport simulator. Separate periods of at least 5 years will be used for calibration and validation of the coupled model.

Historical Atmospheric Data will be extracted from Oregon State University's PRISM Climate Group's time series data with interpolated national and daily coverage from 1895-present. This dataset includes a variety of environmental stressors (Table 2) that can be extracted for specific dates and aggregated across specific ranges. We will examine the persistence of atmospheric stressors on groundwater contamination risk as well as nonlinearities in the intensity of precipitation and temperature trends. For example, we will examine the empirical relationship between groundwater contamination risk and rainfall on (i) the day of water sampling, (ii) the day before water sampling, (iii) the seven days prior to water sampling and (iv) the 30 days prior to water sampling.

Econometric and Machine Learning Analysis: The methodological approaches employed in previous EPA-funded work (RD836942) will be generalized for statewide prediction of private well contamination with many potential contaminated site sources. Residential structures will first be linked hydrologically to their upstream contaminated sources (see "Hydrological Modeling" section). Upstream water-related exposure will take the form

$$E_{i,t} = \sum_{n_{it}} C_{n,t}$$

where $E_{i,t}$ is the exposure level of the $i'th$ residential parcel in time *t* constructed as the sum across all $n_{i,t}$ contaminated sites, $C_{n,t}$, located within residential parcel *i's* upstream catchment in time *t*. Here, exposure might be defined as the pure intersection of the residence with a contaminated sites STM, a pure intersection between a residential address' upstream drainage basin and a contaminated site or some overlap between the STM and the residence. $C_{n,t}$ is defined as a set of contaminated sites that include swine and poultry CAFOs, coal ash impoundments, hazardous waste sites, underground storage tanks, dry-cleaning solvent sites and wastewater treatment sites.

Table 2 Taxonomy of new datasets to be integrated with existing database under proposed award (i. Contaminated sites, ii. Historical groundwater pollution indicators, iii. Severe weather events, iv. Exposure mediating environmental factors).

Variable	*Coverage*	*Temporal Resolution*	*Spatial resolution*	*Source*
(i) Contaminated Sites (cont.)				
Hazardous Waste Sites	2,577	1980-Present	Coordinates	EPA RCRA
Underground Storage Tanks	33,945 sites (8,169 with current permits)	1988-Present	Coordinates	EPA UST
Dry-Cleaning Solvent Sites	433 sites	1997-Present	Coordinates	NC DEQ
Wastewater Treatment	1,147 sites	2001-Present	Coordinates	NC DEQ
(ii) Historical Groundwater Pollution Indicators				
Private Well Samples Organic Chemicals + Pesticides: *(1,3-dichloropropene, methoxychlor, aldrin, hexachlorobenzene, etc.)*	8,151 statewide samples	2008-Present	Residential Address	NC DHHS State Laboratory
(iii) Severe Weather Events				
Mean temp. Minimum temp. Maximum temp. Mean dewpoint temp. Min. vapor pressure deficit Max. vapor pressure deficit Precipitation	Full coverage	1981-present, daily resolution	Residential address	Oregon State Prism Data
Storm Surge Warnings Wind Speed of Tropical Storm Events Arrival Time of Tropical Storm Winds Wind Fields	Tropical storm specific	2008-present, event-hour-day resolution	Vector/Polygons	NOAA NHC
(iv) Exposure Mediating Environmental Factors				
NC Built structures: (*elevation, share of parcel surface impervious, hours of sunlight, building height, pool nearby, pond nearby, etc.)*	Statewide	1880-Present	Coordinates	NC DCR
Soil layers	Statewide	2019	10m Raster	USDA NRCS
Geological formations	Statewide	2005	Polygons	USGS
Tax information: *(home appraisal, last sold date, rental or primary residence, administrative jurisdictions, number of rooms, square feet, zoning, etc.)*	Statewide	2019	Coordinates	County Specific
Built infrastructure: *{waste management, stormwater permitting, public water supplies, etc.)*	Statewide	Varies	Coordinates	NC DEQ

A groundwater contamination event, $P_{i,t}$, will be predicted as a binary outcome of inorganic or microbiological analytes exceeding the maximum contaminant level (MCL) set by the US EPA or state public health agencies. The baseline econometric specification will be estimated using a linear, probit and logistic regression models as coefficient estimates will be easily interpretable as probability changes in the likelihood of a contamination event occurring. These findings will flow naturally into the "risk communication" phase of the project. The most general econometric specification

$$P_{i,t} = \sum_{j} [\beta_{1,j} E_{j,i,t} + \beta_{2,j} S_{i,t} \quad + \beta_{3,j} S_{i,t} E_{j,i,t}] + \gamma_i \quad + \eta_t + \epsilon_{i,t}$$

has a contamination event being predicted by upstream exposure with mediating effects from a vector of local environmental stressors, $S_{i,t}$. Such stressors include but are not limited to soil types, precipitation, air temperature, built structure year and the proximity or existence of public infrastructure such as wastewater and stormwater management. The coefficient $\beta_{1,j}$ represents the increase in the probability of a groundwater contamination event that is associated with an additional upstream contaminated site. The coefficient $\beta_{2,j}$ represents the direct impact of environmental stressors on groundwater contamination risk irrespective of proximity to contaminated sites. For example, sustained rainfall is likely to increase nutrient runoff and increase the probability of nitrate contamination despite no point source sites being located upstream. The coefficient $\beta_{3,j}$ captures the interactive impacts of environmental stressors on groundwater contamination risk downstream of contaminated sites. Here, environmental stressors are likely to take highly non-linear and interactive forms (e.g. quadratic effects of precipitation, interactions between temperature, precipitation and soil types, etc.). These specifications are assumed in the vector, $S_{i,t}$, to limit notational complexity in the proposal.

The γ_i and η_t represent group-specific and time-specific fixed effects. Because the pathway to exposure of each potential contaminant is unique, the group and temporal fixed effects that we include will depend on the particular outcome that we are predicting. Such geographic identifiers have the potential to capture otherwise unobservable variable that may be powerful predictors of contamination events. For example, private wells are managed at the county level in North Carolina, which is likely to influence the detection rate of contamination. Further, well drilling contractors tend to operate within counties, which suggests well depths and structural integrity will be highly correlated within counties. The model's error term is $\epsilon_{i,t}$, which we intend to cluster at the event exposure level (e.g. specific hurricane, flooding or rainfall events across the state).

Other machine learning models, beyond the linear and logistic regression models, will also be employed to better handle the potentially unbalanced nature of our synthesized datasets. We will use the random forest machine learning algorithm, which has been used successfully to predict credit default risk (Figini et al. 2017) and risk of disease (Khalilia et al. 2011). The model adopts multiple, nested decision trees that each lead to a binary prediction, which is appropriate for our research setting. The approach is particularly well-suited for high dimensionality– i.e., many interacting physical and human systems – and unbalanced datasets.

Pediatric Health and Risk Communication. The results from our data analysis will identify residences with the highest probability of groundwater contamination and exposure. Of these households, we will select those that are known to have a newborn or child under the age of 5 living within the home. This selection will occur by linking each year's identifiable vital statistics records with the empirical model's predictions. The research team will coordinate with public health authorities to design and deliver a risk notification to these at-risk households.

North Carolina contains 100 counties each containing a public health department that oversees private well sampling and management. It is therefore not practical for our team to initiate contact and build relationships with each relevant county's public health department. However, counties coordinate efforts through the North Carolina Department of Health and Human Services' On-Site Water Protections Branch (see Wilson Mize letter of support). Here, we will coordinate with NC DHHS to design outreach material that satisfies the standards of our team's graphic designer, our team's pediatrician and the NC DHHS On-Site Water Protections Branch. Such a coordination will ensure the risk notification is acceptable to county public health departments, accessible to the general public and medically appropriate for public dissemination. The "risk messenger" of material will be assigned randomly for each new notification as either our team's pediatrician or the home county's public health department. In both cases, the risk notification material will offer free well water testing to be conducted by the home county's health department and paid for by East Carolina University's Natural Hazards Research.

Hypothesis testing: Hypotheses 1a, 1b and 1c will be testable using the coefficient estimate on the vector of environmental stressors, $\beta_{3,j}$. For example, when predicting the risk of coliform bacteria as the contamination event, $P_{i,t}$, the null hypothesis becomes $\beta_{3,j} > 0$ on precipitation and temperature elements and $\beta_{3,j} < 0$ on proximity (e.g. distance to contaminated site) elements. Hypothesis 3 will be a t-test between two samples with random assignment into a risk messenger treatment. Our null hypothesis is that the rate of follow-up testing will be larger among residences contacted by an ECU pediatrician relative to those contacted by their county health department.

3.a. Innovation

There has been a lack of linking human health and simulating the transport of contaminants using distributed process-based hydrological and water quality models (Brauman, 2015). Some of the challenges to using these complex models for this purpose are the great uncertainty (Beven, 1993; Wellen et al., 2015) and the computing time required calibrate, validate, and run scenarios in the models. There is a trend to use non process-based models for determining the watershed conditions that lead to specific ecosystem outcomes such as harmful algal blooms (Olson and Hawkins, 2013; Nelson et al., 2018). Using statewide hydrologic and water quality data to inform an econometric model to predict hydrologic conditions that increase risk to human health is a major change in approach in the field of hydrologic modeling and would further promote the use of non-process-based modeling in this field.

3.b. Sustainability

Through a combination of the proposed work and the results from our on-going projects, the research team will be able examine how aspects of each pillar of sustainability affect the others in our study area. The focus of the proposed project on protecting and improving human health makes the social pillar a strength. Many of the sources of contaminants in our study area are also the industries that provide income in these rural areas. Our approach will allow us to identify the

sources of contaminants that cause the greatest risk to human health in addition to identifying the natural resources that reduce risk. Natural resources that we are currently investigating include wetlands and vegetated buffers. This approach promotes economic sustainability by putting the focus on protecting and restoring natural resources that protect human health in the areas that are most vulnerable. It does not promote unproven widespread changes that could have a substantial negative effect on the economy. Protecting and restoring ecosystems to protect human health will also provide additional ecosystem services to further enhance environmental sustainability.

3. Expected Results

- Identification of contaminated sites susceptible to breach events during severe weather.
- Interventions that reduce childhood exposures to pathogens and inorganic chemicals.
- Tailored reports delivered to most at-risk neighborhoods across our study area.
- A dedicated and publicly available website and social media platform to disseminate findings.
- A series of publications in the economics, natural sciences, and interdisciplinary journals.

5. Project Management

PI Hochard will coordinate research activities, supervise data management and ensure that project goals are met within the proposed timeline. The management structure of our project will be co-led by PI Hochard and Co-PI Peralta who will regularly coordinate in-person and virtual meetings of PIs and students to maintain cohesion between team members. We will have meetings (1 hour) once per month to update each other on progress. At the beginning of each year, we will meet for a day-long meeting to present formal project updates and discuss goals for the upcoming year.

Name, Inst.	Project Roles
Jacob Hochard	Lead the econometric analysis and machine learning prediction of potentially contaminated water wells. Hochard will oversee the research technician and PhD student focused on data synthesis and econometric modeling. Hochard will support the targeted human health interventions. Hochard will also maintain the project website and lead the technical reports.
Kayla Clark	Co-lead design of the targeted human health interventions in households with newborns that have a high risk of private well contamination at the statewide scale.
David Collier	Co-lead the targeted human health interventions in households with newborns that have a high risk of private well contamination at the statewide scale.
Scott Curtis	Lead the synthesis of historical and spatially-explicit precipitation and temperature data into the econometric modeling of well contamination risk. He will also lead the synthesis of the spatial data for the hydrological modeling.
Randall Etheridge	Lead the hydrological modeling and the supervision of the research technician focused on hydrological modeling. Etheridge will also co-advise the PhD student in Integrated Coastal Sciences and assist with coordination between the econometric and hydro modeling teams.
Ariane Peralta,	Lead the synthesis of statewide soil mapping data and support the supervision of the research technician focused on hydrological modeling. Peralta will also co-advise the PhD student in Integrated Coastal Sciences and co-lead project management with PI Hochard.
Jamie Kruse	Support the econometric analysis and machine learning prediction of potentially contaminated water wells and help oversee the research tech focused on data synthesis and programming.
Additional Personnel	A Ph.D. student in the UW Department of Economics will econometric modeling along with validating the results of each model. The student will assist with technical reports and publications and help coordinate with local health officials. A Research Technician in the Haub School will support data synthesis and econometric modeling to predict water contamination risk. A Research Technician and undergraduate students in ECU Engineering will support hydrological modeling and soil analysis. Undergraduate researchers will support public outreach by working with the county public health departments for sample analysis.

1) **PI Hochard** will be responsible for quality assurance (QA) and quality control (QC) throughout the research project. Hochard is the Knobloch Assistant Professor of Conservation Economics at the University of Wyoming and an adjunct professor in the Department of Economics at East Carolina University. Dr. Hochard will ensure the use of the most rigorous econometric and geospatial data processing methods that adhere with the standard of rigor established in the relevant peer-review literatures. Hochard will also verify the appropriateness of geospatial dataset projections and coordinate systems before the geospatial analysis is conducted.
2) Our **objectives** are to (1) predict groundwater contamination that leads to human exposures, (2) based on predictive models, engage with county health offices to notify at-risk households with a newborn and (3) assess the impact of the risk messenger on risk mitigation choices. We hypothesize: (1a) chemical concentrations and coliform bacteria in wells relates to proximity to contaminated sites during precipitation events, (1b) bacterial contamination depends on source and seasonality, (1c) homes with aging wells are more vulnerable to contaminants, (3) risk communication from an ECU pediatrician promotes households' risk mitigation behaviors. To test these hypotheses, we will synthesize soil, hydrological, meteorological and built infrastructure data alongside a statewide database of private well testing to predict contamination events using econometric and machine learning techniques. Households with a birth in the current year's vital statistics, that are likely to have a contaminated well, will receive an alert and option for water testing from their county health office. The messenger of the alert will be assigned randomly as an ECU pediatrician or a county health official. Findings from new water tests will be used to groundtruth and improve the model's predictive capacity. Our research will (i) identify households most likely to be exposed and vulnerable to chemical and biological contaminants during severe weather, (ii) prevent impairments to cognitive development of newborns and (iii) evaluate the effectiveness of local public health offices partnering with university medical clinicians to communicate health risks.
3) **Project Elements**
    a. Collection of new/primary data:
    b. Use of existing secondary data:
        i. All secondary data sources that will be used during this project are documented in Tables 1 and 2 in the "Research Plan" section, which includes temporal resolutions and are already georeferenced or will be georeferenced based on residential addresses or latitude-longitude coordinates.
        ii. All secondary data sources used in this project will be recognized by citation in any deliverables (e.g. technical reports, peer-reviewed publications, etc.).
        iii. The secondary data sources we are using have been vetted for quality at the federal, state and local levels before being released for research use.
        iv. The quality of data used in this project is unlikely to be an issue of concern.
        v. PI Hochard will control all datasets catalogued in one of his on-campus faculty-issued computers, which enjoys University of Wyoming's security procedures and will be backed up on secure university servers. All data

sources and hyperlinks to sources will be documented on the project's dedicated website.

c. Method development. No new method of analysis will be developed for our proposed project.
d. Development or refinement of models:
    i. We will use an econometric model to conduct our empirical analysis and a basic hydrological model to identify upstream landscape relationships. Both of these models are well developed and published in the pertinent peer-reviewed literatures. No major refinements will be made to the hydrological tools, which are packaged in TauDEM or ArcGIS, or econometric estimators, which are packaged in Stata 15.
e. We will not develop or operate any environmental technology.
f. No surveys will be conducted.

4) PI Hochard will control all datasets catalogued in one of his on-campus faculty-issued computers. Hochard's computers have adequate hard drive space and processing power to conduct the empirical and hydrological analyses. If added processing power is needed to conduct the hydrological analysis, Peralta (as a faculty member in ECU's Department of Biology) has access to a high performance computing core housed in ECU's Department of Biology. The system includes 96 computer cores (Intel Xeon 5650 processors), and remote management from Gridcore. Two quad-core HS22 servers act as the head node and storage node, and a further eight HS22 servers act as the compute nodes, each configured with two 6-core Intel Xeon 5650 processors. A 2U storage enclosure within the BladeCenter chassis contains ten 600 GB 15,000 rpm SAS drives. PI Hochard has licenses for all required software (Stata 16.0 and ArcGIS10.7), which will remain active through the duration of the research project.

Human Subjects Research Statement

The Institutional Review Board (IRB) approval for a current award (EPA RD836942) remains active and on file at East Carolina University (#17-000354) where Hochard is also an adjunct professor in the Department of Economics. This IRB approval governs the use of statewide vital statistics data identifiable at the residential address level. These data will also be used in the proposed project.

The University of Wyoming has recognized the East Carolina University-based protocol to serve as the governing IRB protocol for this study.

Our proposed project will build a collaboration between state health officials, state environmental managers, county health departments, other organizations with a mission of protecting human health and East Carolina University social and natural scientists, a professional designer and physician. As a regional university with a far-reaching and diverse student body, ECU has tremendous institutional prowess in the state. The team's goal is to leverage the institution's visibility around the state and partnerships with local and state government and non-profit organizations to build public trust in rural communities that are traditionally wary of public health notices regarding the potential contamination of their drinking water.

State support: The researchers are working closely with two offices at the NC Department of Health and Human Services (DHHS) and the North Carolina Department of Environmental Quality's Division of Water Resources.

- Sidney Evans, a state statistician at the NC DHHS vital statistics office, has reliably provided residential-level data on birth outcomes since 2017 and has expressed his continued support of our EPA-funded research in the state.
- Wilson Mize, the regional environmental health specialist overseeing NC DHHS' On-Site Water Protection Branch's private well monitoring program has offered to coordinate our contact with county public health departments. Building on Wilson's established relationship in North Carolina's 100 counties is essential to build risk communication notices that are accessible to the general public, medically appropriate and acceptable to local health officials who might be concerned with causing undue panic in communities. Here, our team's graphic designer and pediatrician will work alongside the NC DHHS and county health departments to engage in the most effective manner possible with rural communities.
- Craig Caldwell, a water quality manager with the NC Department of Environmental Quality's Division of Water Resources, has also expressed his support for our proposed project. Craig's knowledge of groundwater resources throughout the state will be vital for identifying data for including in our model and for evaluating potential sources of contamination.

Nonprofit organization support:

- Sound Rivers is a nonprofit organization that guards the health of the Neuse and Tar-Pamlico River Basins. Their mission is to monitor and protect the Neuse and Tar-Pamlico River watersheds covering nearly one quarter of North Carolina, and to preserve the health and beauty of river basins through environmental justice. A letter of support has been issued from Sound Rivers who has far-reaching contacts with a network of community organizations other non-profit groups throughout North Carolina and underserved American Native Americans tribes.
- The North Carolina Agromedicine Institute (NCAI) is a University of North Carolina inter-institutional institute whose partners are East Carolina University, North Carolina State University, and North Carolina Agricultural and Technical State University. The mission of the institute is to promote health and safety of farmers, fishermen, foresters, their workers and their families through research, prevention/intervention, and

education/outreach. The NCAI has expressed their support of our project opening an avenue to other UNC system institutions that have strong community relationships in other parts of the state.

Planned Acts of Community Engagement and Communication:

- The research team will work closely with each of the supporting organizations to determine if there are additional research questions or known disease/illness hotspots that can be investigated using our model. We will schedule regular phone calls or web conferences with each supporting organization throughout the project to seek their feedback.

- A report characterizing our findings will be published and disseminated to the NC DHHS On-Site Water Protection Branch office, which will be made available to North Carolina's 100 county public health departments. This report will include summaries of model performance, the number of interventions and the accuracy of model predictions. The reports will also document the prognosis for county health offices to pair with medical clinicians at regional universities to facilitate risk communication aimed at improving private well testing coverage statewide. We will also discuss pathways for more formal collaborations with county public health departments that wish to use our data-driven approach to help support their private well management programs more broadly.

  A digitally-designed and interactive version of this report will be tailored for public consumption and hosted on the team's dedicated project website.

- The team will build on its social media presence in these communities by expanding the reach of our dedicated project website, www.ourncwater.org, from the six counties in the previous EPA award study area to the state's 100 counties.

- The team's graphic designer and pediatrician will build a relationship with county health offices and the NC DHHS office to build risk communication notices that are accessible to the general public, medically appropriate and acceptable to local health officials who might be concerned with causing undue panic in communities. These materials are expected to reach those households that are most underserved in rural areas and least likely to be able to afford private well testing.

- The team will present results at state-level conferences, such as the North Carolina Water Resources Research Institute Annual Conference, that are attended by state and local officials. These presentations will further inform the officials about the capabilities of our model and seek feedback on ways to alter to model to make the output more useful for protecting human health.

Data Plan

In accordance with the policies of the US Environmental Protection Agency, the research team will maintain data to support timely publication of results and to facilitate sharing with the broader research community. This Data Management Plan encourages primary data "commonly accepted in the scientific community as necessary to validate research findings" to be made available at little or no incremental cost. The release of data involving human subjects is subject to policies and restrictions in protocols adopted and approved by East Carolina University's Institutional Research Board (IRB) under human subject's assurance number UMCIRB 18-00071.

Data and Metadata Format and Content

The datasets will be described using common data formats, such as spreadsheet (XLSX) and comma delimited files (CSV). A ReadMe file will be provided containing a copy of the survey questions and the water quality testing that was conducted. The routines used to manipulate and analyze the data, descriptions of all variable names, and the sources of all secondary data with date accessed will also be included.

Policies for Access and Sharing

Curated data will be available through ScholarShip, East Carolina University's Institutional Repository. It is a digital archive for scholarly output of the ECU community. Its mission is to capture, preserve and make available the intellectual output of the East Carolina University's faculty, staff, and students. Hochard, as an adjunct professor at East Carolina Univeristy, retains full access to the institutional repository. Likewise, data will be backed up on the equivalent system at the host institution: University of Wyoming. In addition, data will be made available at NHERI DesignSafe to assure that it is broadly available to the hazards community. The PI or lead author of any publications or conference proceedings resulting from this project will ensure that the materials are deposited for public access within 12 months of publication. All materials will contain acknowledgement of EPA support. All data collected from human subjects will be anonymized or sufficiently aggregated so that personally identifiable information is removed with a minimum number of demographic variables included in the released dataset. Data will be released to the academic community concurrent with publication of findings.

All water quality data of sufficient quality will be made publicly available by publishing on the open access repository Dryad. Water quality testing protocols will be provided as metadata. Data and accompanying metadata, based on the Ecological Metadata Language standard, will be published as comma or tab-delimited text files suitable for use in statistical software will be published. In order to ensure reproducibility, statistical scripts will be maintained on a shared GitHub repository.

The Stata 14.0 data file used in our econometric analysis will be made available with all private information linked back to residential addresses redacted. Releasing such a dataset will ensure that the privacy of individuals, as it relates to residential locations, is maintained while other researchers retain the ability to replicate our empirical results. Data will be stored on PI

Hochard's university-issued computer and backed up on University of Wyoming's secure servers.

Plan for Archiving and Preservation

During the project, the data will be stored on the secure University of Wyoming and East Carolina University servers that are password protected storage space available to the PI and CO-I as well as their password protected personal computers.

The Pirate Drive, housed at East Carolina University, provides long-term, encrypted storage of data and regular backups. Copies of the survey instrument, the protocol, the metadata, the data dictionary, statistical analyses, and all published manuscripts from this study will be deposited in the Pirate Drive. At the conclusion of the project the complete dataset will be archived in REDCap (Research Electronic Data Capture) a secure, HIPAA- and FERPA-compliant web-based application developed by Vanderbilt University. ECU is a member of the REDCap Consortium. ECU houses REDCap (the database and servers) which means that all the data is secure within ECU's IT infrastructure.

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BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Hochard, Jacob P.

eRA COMMONS USER NAME (credential, e.g., agency login): HOCHARDJ

POSITION TITLE: Assistant Professor of Economics

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Gettysburg College	BA	05/2011	Economics & Environmental Studies
University of Wyoming	PhD	05/2015	Economics

A. Personal Statement

Natural resources in rural areas support the livelihoods of those who lack immediate access to well-functioning markets for healthcare, health services and public utilities. Much value generated from our rural natural resources affect market-based activities only indirectly and therefore risk being overlooked by policymakers. Further, rural underserved locations are likely to be overlooked by centralized environmental monitoring efforts leaving rural households increasingly vulnerable to environmental exposures. My research program applies quantitative empirical approaches at the intersection of economics, public health and land use policy to better understand the complex relationships between human decisions and the provision of ecosystem services to benefit human health and well-being in rural areas.

B. Positions and Honors

Positions and Employment

2019-present Early Career Faculty Fellow, U.S. EPA and Oak Ridge Institute for Science and Education
2015-present Assistant Professor, Department of Economics, ECU
2015-present Research Affiliate, Center for Natural Hazards Research, ECU
2018-present Assistant Research Scientist, Integrated Coastal Programs, ECU
2018-present Research affiliate, NC Agromedicine Institute
2015-2018 Assistant Research Scientist, Institute of Coastal Science and Policy, ECU
2011-2015 Graduate Research Assistant, Department of Economics. U. of Wyoming

Professional Memberships

2011-present Resource Modeling Association (RMA)
2012-present Agricultural and Applied Economics Association (AAEA)
2012-present The American Economic Association (AEA)

Professional Service (selected)

2017-present Albermarle-Pamlico National Estuary Partnership (APNEP), Technical Advisor
2016 National Institute of Food and Agriculture (NIFA)–Agricultural and Food Research Initiative (AFRI) Environmental and Natural Resource Economics Area Grants Program Reviewer
2016 Agricultural and Applied Economics Association (AAEA) Review Panelist
2012-present Journal Referee service for *Environmental and Resource Economics (4), Ecological Economics (2), American Journal of Agricultural Economics (2), Journal of Environmental Economics and Management (2), Ecohealth, Journal of Economic Behavior and Organization, Journal of Flood Risk Management, Journal of Housing Economics, Marine and Resource Economics, Resource and Energy Economics, Sustainability, Proceedings of the National Academy of Sciences.*

ECU Service (selected)

2019-present Faculty Task Force on Facilities and Administrative Costs, Member

2016-present Coastal Maritime Council–East Carolina University, Advisory Committee Member
2015-present Department of Economics Undergraduate Program Committee, Committee Member
2018-2019 Cluster Search in Integrated Coastal Programs, Core Hiring Committee Member
2017 Department of Biology Coupled Natural-Human Services, Hiring Committee Member.
2016 Department of Economics Urban Economics, Hiring Committee Member.
2016 Center for Sustainability Environmental Engineer, Hiring Committee Member

Honors (selected)

2018 Harriot College of Arts and Sciences Dean's Early Career Award
2018 East Carolina University Coastal Scholar Award
2018 ECU Residence Hall Honored Instructor Award
2017 EAERE Best Publication in Environmental and Resource Economics
2017 East Carolina University's University Scholars Award
2015 University of Wyoming Promoting Intellectual Engagement (PIE) Teaching Award
2014 Resource Modeling Association (RMA) Best Graduate Student Paper

C. Contributions to Science

1. **Rural Water Resources and Human Health Outcomes**
   a. Garg, T., S. Hamilton, J. Hochard, E. Kresch and J. Talbot. "(Not so) gently down the stream: River pollution and health in Indonesia". *Journal of Environmental Economics and Management.* 2018.
   b. Hochard, J., R. Etheridge, M. Gomez, Y. Li, A. Peralta, C. Sims and T. Vogel. "Casing out Contaminants: Avoidance Behavior Along the Hydrogeologic Gradient. *In preparation.* 2019.
   c. Hochard, J. and Y. Li. Expecting Mother Nature: Uncertain Hurricane Forecasts Impair Birth Outcomes. *In preparation*. 2019.
2. **Rural Livelihoods, Climate Change and Land Degradation**
   a. E. Barbier and Hochard, J."Poverty-Environment Traps". Accepted at *Environmental and Resource Economics*. 2019.
   b. Hochard, J., S. Hamilton and E. Barbier. "Mangroves shelter economic activity from cyclones". *Proceedings of the National Academy of Sciences* 116 (25) 12232-12237. 2019.
   c. Kruse, J., and J. Hochard. "Economics, Insurance, and Flood Hazards" *Southern Economic Journal* 85 (4) 1027-1031. 2019.
   d. Barbier, E., and J. Hochard. "Land degradation and poverty." *Nature Sustainability* 1 (11). 2018.
   e. Barbier, E. and J. Hochard. "The Impacts of Climate Change on the Poor in Disadvantaged Regions. *Review of Environmental Economics and Policy* (REEP) 12(1) 26-47. 2018.
   f. Barbier, E. and J. Hochard. Poverty, Rural Population and Climate Change. *Environment and Development Economics*. 1-23. 2017.
   g. Hochard, J., and E. Barbier. "Market accessibility and economic growth: Insights from a new dimension of inequality." *World Development* 97: 279-297. 2017.
   h. Hochard, J. and E. Plous-Kresch. "Remote Sensing Supports Economic Inference in Developing Countries". Chapter 13 in Kruse, Crompvoets and Pearlman (eds). GEOValue: The Socioeconomic Value of Geospatial Information. Taylor and Francis Group, Boca Raton, Florida, 2017.
   i. Barbier, E., and J. Hochard. "Does Land Degradation Increase Poverty in Developing Countries?." *PLOS ONE* 11(5). 2016.
   j. Barbier, E., R. Lopez, and J. Hochard. "Debt, poverty and resource management in a rural smallholder economy." *Environmental and Resource Economics* 63(2). 2016.
   k. Barbier, E. and J. Hochard. "Development, Ecology and the Environment" Chapter 33 in J. Ghosh, R. Kattel and R. Reinert (eds). Elgar Handbook of Alternative Theories of Economic Development. Edward Elgar, Cheltenham, UK, 2016.
3. **Management of Ecosystem Services**
   a. Hochard, J. and D. Finnoff. "Cross-Jurisdictional Management of a Trophy-Hunted Species. *Journal of Theoretical Biology* 420, 41-52. 2017.
   b. Sims, C., D. Finnoff, A. Hastings, and J. Hochard. "Listing and Delisting Thresholds under the Endangered Species Act." *American Journal of Agricultural Economics* 99, no. 3: 549-570. 2017.
   c. Hochard, J. and D. Finnoff. "Gray wolf population projection with intraspecific competition". *Natural Resource Modeling* 27(3), 360-375. 2014.

Complete list of published works: http://www.jacobhochard.com/fullpub

KAYLA CLARK
Teaching Assistant Professor
School of Art and Design
East Carolina University

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EDUCATION

July, 2019 — **Master of Fine Arts, Graphic Design**
School of Art and Design
East Carolina University, Greenville, NC

May, 2014 — **Bachelor of Arts, Graphic Design**
School of Fine Arts and Art History
University of Wyoming, Laramie, WY

PROFESSIONAL EXPERIENCE *(selected)*

2019 – Present — **ECU School of Art and Design**
Teaching Assistant Professor, Graphic Design

2016 – Present — **Kiss Cut Studio, Letterpress & Design**
Sole Proprietor

2013 – 2016 — **17 Points Design & Marketing Studio**
Founder and Creative Director

2014 – 2016 — **Ivinson Memorial Hospital & Foundation**
Creative Director and Marketing Coordinator

TEACHING *(selected)*

2019 — **Applying Art, Design and Interactivity Principles to Enhance Science Communication, Ecological Society of America Annual Meeting**
Workshop Instructor
Louisville, Kentucky

University of Alaska Anchorage, Department of Art
Guest Printer
Anchorage, Alaska

FA 2017 – FA 2019 — **ART 2200 & ART 2210 *(Graphic Design Studio 1)*, ECU**
SP 2018 — **School of Art and Design**
Instructor
Greenville, NC

SP 2017 — **Bridging with Buttons, University of Sharjah: College of Fine Arts and Design**
Workshop Instructor
Sharjah, United Arab Emirates

GRANTS & CONTRACTS *(selected)*

(in preparation) **Princeville Mobile Museum, North Carolina State University School of Architecture and College of Design**
"Freedom River"
Co-Principal Investigator
TBA

Greenville Community Enrichment Grant
"Sounds of the Sound"
Co-Principal Investigator
TBA

2017 **Community Collaborative Research Grant Program**
"Investigating Biological Invasions in NC Coasts & Estuaries; From A to Zombie"
Lead Designer & Contractor
Awarded $16,000 from NC Sea Grant

EXHIBITIONS & PRESENTATIONS *(selected)*

2019 **You the Candidate, Solo Exhibition & Research Talk**
Student Center, East Carolina University
Greenville, North Carolina

Design Archive, Solo Exhibition
Burroughs Wellcome Gallery, School of Art and Design, East Carolina University
Greenville, North Carolina

2018 **Printing: Peaks & Plains**
Research Presentation at Research and Creative Week, East Carolina University
Greenville, North Carolina

2017 **dataSTEAM Exhibition with Dornith Doherty and Scott Groenger**
Janice Hardison Faulkner Gallery, East Carolina University
Greenville, North Carolina

Cultural Exchange Exhibition
University of Sharjah, College of Fine Arts and Design
Sharjah, United Arab Emirates

CONFERENCES & WORKSHOPS *(selected)*

2019 **Explore Europa, Joby Harris, NASA Jet Propulsion Lab**
East Carolina University School of Art and Design
Greenville, North Carolina

2018 **Typographic Summer Program**
Dafi Kühne of Baby Ink Twice
Näfels, Switzerland

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Collier, David

eRA COMMONS USER NAME (credential, e.g., agency login): collierd

POSITION TITLE: Associate Professor of Pediatrics

a. EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)*

INSTITUTION AND LOCATION	DEGREE (if applicable)	START DATE MM/YYYY	END DATE MM/YYYY	FIELD OF STUDY
North Carolina State University	BS	01/1978	05/1980	Animal Science
University North Carolina Chapel Hill	PHD	09/1983	05/1989	Microbiology/Immunology
Brody School of Medicine	MD	08/1977	05/2001	Medicine
University North Carolina Chapel Hill	N/A	09/1975	12/1977	Chemistry/Biology
University Health System/Brody School of Medicine, Greenville, NC	Resident	06/2001	04/2004	Pediatrics

A. Personal Statement. I am an American Board of Pediatrics board-certified physician/scientist with special expertise in bariatric (obesity) medicine and a particular focus on the role of xenobiotics and other environmental factors in the development and maintenance of obesity and associated co-morbidities in children. I am a full member of North Carolina State University's Center for Human Health and the Environment (CHHE) and a Co-I on this P30 funded Environmental Health Center (P30ES025128; Smart, R. PI) and Co-I on a subcontract evaluating PFAS exposure in the Cape Fear River valley (R21ES02935: Hoppin, J. PI). In this role I oversee the clinical analysis of human samples in PFAS exposed human populations, help interpret human clinical lab data, provide medical consultations and help ensure accurate and useful report back on health outcomes in human research subjects.

B. Positions and Honors

1. Positions and Employment

1989 - 1995 Research Biologist, E.I. DuPont de Nemours and Co., Inc., Wilmington, DE
1995 - 1997 Research Instructor, Microbiology/Immunology, Brody School of Medicine
2004 - 2007 Associate/Co-Director, Pediatric Healthy Weight Research and Treatment Center
2004 - 2011 Assistant Professor of Pediatrics , Brody School of Medicine
2005 - 2016 Vice Chair for Research, Dept. Pediatrics, Brody School of Medicine
2006 - Adjunct Associate Professor, Depts Family Medicine and Kinesiology, ECU
2007 - Director, Pediatric Healthy Weight Research and Treatment Center
2009 - Associate Director, East Carolina Diabetes and Obesity Institute
2011 - 2017 Associate Professor of Pediatrics, Brody School of Medicine
2015 - Liaison, Integrative Health Sciences Facility Core, NC State University Center for Human Health & the Environment
2015 - 2017 Associate Professor (joint appointment), Center for Health Disparities, ECU
2016 - 2018 Assistant Director for Clinical Research Development, Clinical Trials Office Brody SOM
2017 - Professor of Pediatrics

2. Other Experience and Professional Memberships

1989 - Member, Sigma Xi

2003 -	Member, Academic Pediatric Society
2004 -	Fellow, American Academy of Pediatrics
2006 - 2012	Member, Healthy Lives/Healthy Choices Community Task Force
2007 - 2012	Medical Director, Pediatric Healthy Weight Case Management Program
2008 - 2011	Member, Advisory Board "Fit for Residents" national obesity curriculum for teaching residents
2009 - 2016	President, Brody School of Medicine Alumni Society
2011 - 2011	Member, NIH Scientific Review Group/Special Emphasis Panel ZRG1 EMNR-D (55)
2012 -	Member, The Obesity Society
2013 - 2016	Member Integrated Biology Track, The Obesity Society Scientific Review Committee
2014 - 2017	Co-Director , APA Obesity Special Interest Group
2014 -	Member, NCSU Center for Human Health and the Environment
2016 –	Associate Director, Research Distinction Track, Brody School of Medicine
2017 - 2019	Steering Committee member, NC Biotechnology Center Precision Health Collaborative

3. Honors

1992 - 1993	Excellence in Engineering Award, E.I. DuPont de Nemours Co., Inc.
2000 - 2001	Eugene Furst Student Research Award, Brody School of Medicine
2007 - 2015	Best Doctors in America, BDA
2008	Invited Keynote Speaker, BSOM White Coat Ceremony
2009 - 2015	Top Doctors, Healthy Living Magazine
2010	Teacher-Scholar Award, East Carolina University
2011	Centennial Award for Excellence, East Carolina University
2017	Inducted member of American Pediatric Society
2019	Centennial Award for Spirit (service), East Carolina University

C. Contribution to Science

1. **A total of 57 peer reviewed publications are available at**:
https://www.ncbi.nlm.nih.gov/myncbi/browse/collection/49030072/?sort=date&direction=descending

D. Additional Information: Research Support and/or Scholastic Performance

1. R21ES029353 (Hoppin, J. PI) 11/01/17 – 10/31/19
Assessing impact of drinking water exposure to GenX (hexafluoropropylene oxide dimer acid) in the Cape Fear River Basin, North Carolina
Role: Co-Investigator (0.48 calendar months)

2. P30ES025128 (Smart, R. PI) 04/01/2015 – 3/31/2020
"Center for Human Health and the Environment"
Role: Investigator (1.2 calendar months)

3. 2UO1HG006487-05 (Berg, J. PI) 06/01/2017 - 05/31/2021
"NC GENES2: North Carolina Clinical Genomic Evaluation by Next-gen Exome Sequencing 2"
Role: Site PI (1.2 calendar months)

4. 1U01AR071128-01 (Kraus, W. PI) 07/1/2017 – 06/30/2021
NIH Common Fund/NIAMSH
"Molecular Transducers of the Health Benefits of Exercise Intensity and Mode"
Role: Investigator

BIOGRAPHICAL SKETCH: SCOTT CURTIS

Distinguished Professor, Department of Geography, Planning and Environment
East Carolina University
Brewster A232, Mail Stop 557, Greenville, NC 27858
252-328-2088 • curtisw@ecu.edu

a. Professional Preparation

University of Virginia	Charlottesville, VA	Environmental Sciences	BA, 1993
University of Wisconsin	Madison, WI	Atmospheric and Oceanic Sciences	MS, 1994
University of Wisconsin	Madison, WI	Atmospheric and Oceanic Sciences	PhD, 1998

b. Appointments

Distinguished Professor, Thomas Harriot College of Arts and Sciences East Carolina University	2017-Present
Professor, Department of Geography, Planning and Environment East Carolina University	2015-Present
Associate Professor, Department of Geography, East Carolina University	2009-2015
Assistant Professor, Department of Geography, East Carolina University	2003-2009
Adjunct Assistant Professor, Department of Geography, University of Maryland Baltimore County; Joint Center for Earth Systems Technology (affiliated with NASA Goddard Space Flight Center	1998-2003

c(i). Publications – last three years**:**

1. Curtis, S., 2019: Means and long-term trends of global coastal zone precipitation. *Scientific Reports*, 9:5401, doi:10.1038/s41598-019-41878-8
2. Phan, M.D., B.E. Montz, S. Curtis, and T.M. Rickenbach, 2018: Weather on the go: An assessment of smartphone mobile weather applications. *Bulletin of the American Meteorological Society*, 99, 2245-2257.
3. Curtis, S., T. Crawford, M. Rahman, B. Paul, G. Miah, M. R. Islam, and M. Patel, 2018: A hydroclimatological analysis of precipitation in the Ganges-Brahmaputra-Meghna river basin. *Water*, 10, 1359, doi:10.3390/w10101359.
4. Munroe, R., B.E. Montz, and S. Curtis, 2018: Getting more out of storm surge forecasts: Emergency support personnel needs in North Carolina. *Weather, Climate, and Society*, 10, 813-820.
5. Gamble, D.W., D. Burrell, J. Popke, and S. Curtis, 2017: Contextual analysis of dynamic drought perception among small farmers in Jamaica. *Climate Research*, 74, 109-120.
6. Curtis, S., 2017: The Madden-Julian Oscillation: A tool for regional seasonal precipitation outlooks? *Atmosphere*, 8, 180, doi:10.3390/atmos8090180.
7. Munroe, R., and S. Curtis, 2017: Storm surge evolution and its relationship to climate oscillations at Duck, NC. *Theoretical and Applied Climatology*, 129, 185-200.
8. Leorri, E.S., A.L. Woodson, S. Culver, D. Mallinson, P. Parham, R. Thunell, V.R. Vijayand, and S. Curtis, 2017: Sea-surface temperatures for the last 7200 years from the eastern Sunda Shelf, South China Sea: climatic inferences from planktonic foraminiferal Mg/Ca ratios. *Quaternary Science Reviews*, 165, 13-24.

9. Douglass, D.H., R.S. Knox, S. Curtis, B.S. Giese, and S. Ray, 2017: Historical phase-locked El Niño episodes. *Atmospheric and Climate Sciences*, 7, 48-64.
10. Curtis, S., and D. Gamble, 2016: The boreal winter Madden Julian Oscillation's influence on summertime precipitation in the greater Caribbean. *Journal of Geophysical Research–Atmospheres*, 121, 7592-7605, doi:10.1002/2016JD025031.
11. Popke, J., S. Curtis, and D.W. Gamble, 2016: A social framing of climate change discourse and policy: adaptation, resilience, and vulnerability in a Jamaican agricultural landscape. *Geoforum*, 73, 70-80.
12. Curtis, S., and D. Douglass, 2016: Phase-locked tropical Pacific precipitation. *Atmospheric Science Letters*, 17, 169-176.

c(ii). Publications – five other significant publications:

1. Hao, H., P. Long, and S. Curtis, 2012: Attitudes of property owners to climate change considerations and their effects on future property values in coastal communities. *Journal of Risk Analysis and Crisis Response*, 2(4), 285-291.
2. Curtis, S., P. T. Long, and J. Arrigo, 2011: Climate, Weather, and Tourism: Issues and Opportunities. *Bulletin of the American Meteorological Society*, 92, 361-363.
3. Curtis, S., 2008: The Atlantic multidecadal oscillation and extreme daily precipitation over the US and Mexico during the hurricane season. *Climate Dynamics*, 30, 343-351.
4. Curtis, S., T. W. Crawford, and S. A. Lecce, 2007: A comparison of TRMM to other basin-scale estimates of rainfall during the 1999 Hurricane Floyd flood. *Natural Hazards*, 43, 187-198.
5. Curtis, S., A. Salahuddin, R. F. Adler, G. J. Huffman, G. Gu, and Y. Hong, 2007: Precipitation extremes estimated by GPCP and TRMM: ENSO relationships. *J. Hydrometeor.*, 8, 678-689.

RANDALL ETHERIDGE
Assistant Professor, Department of Engineering, Center for Sustainable Energy and Environmental Engineering
East Carolina University
Rivers RW-214, Mail Stop 117, Greenville, NC 27858
252-737-1930 • etheridgej15@ecu.edu

Professional Preparation

North Carolina State University	Raleigh, NC	Biological Engineering	BS, 2008
North Carolina State University	Raleigh, NC	Biological and Agricultural Engineering	MBAE, 2010
North Carolina State University	Raleigh, NC	Biological and Agricultural Engineering	PhD, 2013

Appointments

Assistant Professor, Department of Engineering, Center for Sustainable Energy and Environmental Engineering, East Carolina University	2015-Present
Adjunct Assistant Professor, Department of Biology, East Carolina University	2016-Present
Agricultural Engineer, Southwest Florida Water Management District	2013-2015
Visiting Researcher, Finnish Environment Institute (SYKE)	2009-2010

Select Publications

J. R. Etheridge, M. Randolph, C. Humphrey. 2019. Real-time estimates of *Escherichia coli* concentrations using ultraviolet-visible spectrometers. Journal of Environmental Quality. doi: 10.2134/jeq2018.08.0294.

J. R. Etheridge, M. R. Burchell II, F. Birgand. 2017. Can created tidal marshes reduce nitrate export to downstream estuaries? Ecological Engineering 105:314-324.

J. R. Etheridge, F. Birgand, M. R. Burchell II. 2015. Quantifying nutrient and suspended solids fluxes in a constructed tidal marsh following rainfall: The value of capturing the rapid changes in flow and concentrations. Ecological Engineering 78:41-52. doi:10.1016/j.ecoleng.2014.05.021.

C. L. Osburn, M. P. Mikan, **J. R. Etheridge**, M. R. Burchell II, F. Birgand. 2015. Seasonal variation in the quality of dissolved and particulate organic matter exchanged between a salt marsh and its adjacent estuary. Journal of Geophysical Research: Biogeosciences 120. doi:10.1002/2014JG002897.

K. Granlund, K. Rankinen, **R. Etheridge**, P. Seuri, J. Lehtoranta. 2015. Ecological recycling agriculture can reduce inorganic nitrogen losses – model results from three Finnish catchments. Agricultural Systems 133: 167-176. doi:10.1016/j.agsy.2014.10.015.

J. R. Etheridge, F. Birgand, J. A. Osborne, C. L. Osburn, M. R. Burchell II, J. Irving. 2014. Using in-situ UV-Visual spectroscopy to measure nitrogen, carbon, phosphorus, and

suspended solids concentrations in a brackish tidal marsh. Limnology and Oceanography: Methods 12: 10-22. doi:10.4319/lom.2014.12.10.

J. R. Etheridge, F. Birgand, M. R. Burchell II, A. Lepistö, K. Rankinen, K. Granlund. 2014. Technical note: Alternative in-stream denitrification equation for the INCA-N model. Hydrology and Earth System Sciences 18: 1467-1473. doi:10.5194/hess-18-1467-2014.

J. R. Etheridge, A. Lepistö, K. Granlund, K. Rankinen, F. Birgand, M. R. Burchell II. 2014. Reducing uncertainty in the calibration and validation of the INCA-N model by using soft data. Hydrology Research 45(1): 73-88. doi:10.2166/nh.2013.039.

K. Rankinen, K. Granlund, **R. Etheridge**, P. Seuri. 2014. Valuation of nitrogen retention as an ecosystem service on a catchment scale. Hydrology Research 45(3): 411-424. doi:10.2166/nh.2013.239.

J. R. Etheridge, F. Birgand, M. R. Burchell II, B. T. Smith. 2013. Addressing the fouling of in-situ UV-Visual spectrometers used to continuously monitor water quality in brackish tidal marsh waters. Journal of Environmental Quality 42(6): 1896-1901. doi:10.2134/jeq2013.02.0049.

Synergistic Activities

1. National Science Foundation Reviewer: Panelist (2016, 2017, 2018); Ad-hoc (2017)
2. Reviewer: NSF Panelist (2016, 2017, 2018); NSF Ad-hoc reviewer (2017); Journal of American Water Resources Association, Ecological Engineering, Journal of Geophysical Research: Biogeosciences, Water Resources Research, Ecological Restoration, Science of the Total Environment, Sustainability, Water, Hydrology Research, Environmental Science: Processes & Impacts, Journal of Fish and Wildlife Management, Marine Technology Society Journal
3. Chair (2018-2020) and Vice Chair (2016-2018) of American Society of Agricultural and Biological Engineers Committee NRES-253: Riparian Zones, Floodplains, and Wetlands
4. Associate Editor: Transactions of the ASABE and Applied Engineering in Agriculture; topics related to natural resources & environmental systems
5. Public Service: Albemarle-Pamlico National Estuary Partnership Science & Technical Advisory Committee
6. Engaging citizens of eastern North Carolina in the process of solving problems their communities are facing related to water quality and flooding through participating in multiple interactive public meetings.
7. As the coordinator for the environmental engineering concentration at ECU, I have helped multiple rural communities evaluate solutions to their flooding and water quality problems through leveraging the expertise of senior engineering students in their capstone course to work with these communities.
8. Professional Engineer, North Carolina Board of Examiners for Engineers and Surveyors, License 043787

BIOGRAPHICAL SKETCH: Jamie Brown Kruse

a. Professional Preparation

University of Nebraska-Lincoln	Ag Honors	B.S. with distinction, 1979
Colorado State University-Ft. Collins	Ag Economics	M.S. 1983
University of Arizona-Tucson	Economics	Ph.D. 1988

b. Appointments

2012-	THCAS Distinguished Professor of Economics, East Carolina University
2014-	Sr. Scientist, Institute for Coastal Science and Policy, East Carolina University
2004-2012	Professor, Department of Economics, East Carolina University
2004-	Director, Center for Natural Hazards Research, East Carolina University
2010	Chief Economist and Sr. Advisor for the Social Sciences (IPA), National Oceanic and Atmospheric Administration (NOAA)
2006-8	Director, Center for Coastal Systems Informatics and Modeling, East Carolina University
2005-6	Fellow, FDIC Center for Financial Research, Washington, D.C.
2001-2	Eidgenossische Technische Hochschule (ETH) Zurich (Visiting Professor)
1996-2004	Texas Tech University
1988-96	University of Colorado-Boulder

c.i. Publications-Five most closely related:

Wang, D., R. Davidson, **J. Kruse,** L. Nozick, and J. Trainor**,** "Homeowner purchase of insurance for hurricane and flood protection," (forthcoming) *Natural Hazards Review* 2017. (NSF 1433662)

Shan, X., Y. Gao, Y. Kesete, R. Davidson, L. Novick, and **J. Kruse,** "Market Insurance and Self-Insurance through Retrofit: Analysis of Hurricane Risk in North Carolina," *Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering*, 10 pages 3(1) March 2017 http://ascelibrary.org/doi/10.1061/AJRUA6.0000887. (NSF 1433662)

Ericson, R. and J. Kruse, "Preference Representations for Catastrophic Risk Analysis," chapter in Economics of the Global Environment edited by G. Chichilnisky and R. Rezal, Springer International Publishing AG, 2015.

Bin, O., T. Crawford, **J. Kruse**, and C. Landry, "On the Importance of Time for GIS View Measures and Their Use in Hedonic Property Models," *Transactions in GIS*, 18(2) 234-252, 2014.

Bin, O., P. Hindsley, **J. Kruse**, C. Landry, J. Whitehead, and K. Wilson, "Weathering the Storm: Measuring Household Willingness-to-Pay for Risk-Reduction in Post-

Katrina New Orleans," *Southern Economic Journal 77*(4), 991-1013, 2011. (NSF 0554987)

c.ii. Five other significant publications:

J. Kruse, "A Celebration of Vernon Smith's 90th Birthday and Lifetime Contributions to Economics and Beyond: Experiments that Inform Policy," *Southern Economic Journal*, doi: 10:1002/soej. 12197, 2017.

Peng, J., X. Shan, Y. Gao, Y. Kesete, R. Davidson, L. Novick, and **J. Kruse,** "Modeling the integrated roles of insurance and retrofit in managing natural disaster risk: a multi-stakeholder perspective," *Natural Hazards* 74:1043-1068, 2014. (NSF 1433662)

Bin, O., **J. Kruse** and C. Landry, "Flood Hazards, Insurance Rates, and Amenities: Evidence from the Coastal Housing Market," *Journal of Risk and Insurance* 75(1) 2008, pp.63-82.

Kruse, J., K. Simmons and D. Smith, "Valuing Mitigation: Real Estate Market Response to Hurricane Loss Reduction Measures," *Southern Economic Journal*, Vol. 68, No. 3, pages 660-71, January 2002.

Kruse, J., S. Rassenti, S. Reynolds and V. Smith, "Bertrand-Edgeworth Competition in Experimental Markets," *Econometrica.* 62(2):343-371, 1994

d. Synergistic Activity

Guest Editor with J. Hochard, "Economics and Flood Risk Symposium," *Southern Economic Journal* expected publication date Spring 2018.

Editor with F. Pearlman and J. Crompvoets, *GEOValue: the socioeconomic value of geospatial information*, publisher Taylor and Francis, (in press) 2018.

Elected to Board of Trustees, Southern Economics Association 2016-2020.

Invited attendee, White House Forum on Smart Finance for Disaster Resilience, sponsored by the White House Council on Environmental Quality and National Security Council, Washington, DC, 2016.

Workshop Organizer, "Data-to-Decisions: Valuing the Societal Benefit of Geospatial Information," sponsored by NASA, USGS, IEEE-USA, International Social Science Council, Group on Earth Observations, and OECD, Paris, France 2016.

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Peralta, Ariane L.

eRA COMMONS USER NAME (credential, e.g., agency login):

POSITION TITLE: Assistant Professor of Biology

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE	Start Date	End Date	FIELD OF STUDY
University of Illinois at Urbana-Champaign, Urbana, IL	BS	08/1999	05/2003	Honors Biology and Chemistry
University of Illinois at Urbana-Champaign, Urbana, IL	MS	08/2003	08/2006	Ecology and Evolutionary Biology
University of Illinois at Urbana-Champaign, Urbana, IL	PhD	08/2007	11/2011	Ecology, Evolution, and Conservation Biology
Michigan State University, Kellogg Biology Station, Hickory Corners, MI	Postdoc	12/2011	11/2012	Microbial Ecology and Agroecology
Indiana University, Bloomington, IN	Postdoc	12/2012	12/2013	Microbial Ecology

A. Personal Statement

Humans have manipulated ecosystems to keep pace with demands for clean water, food, fiber and fuel. These changes in land use can have lasting impacts on contemporary ecosystems, especially on soil microorganisms involved in regulating biogeochemical processes. I use an interdisciplinary approach to understand how anthropogenic manipulation of our landscape influences microbial community structure and function. My research program has three main foci spanning basic to applied ecology: 1) to examine how land use change, namely diversifying human-modified landscapes, influences microbial community structure for enhanced ecosystem services (e.g., nutrient cycling, climate change mitigation), 2) to evaluate how land use legacies influence plant-soil-microbial interactions, and 3) to investigate the influence of natural and anthropogenic environmental gradients impact microbial community structure and function (NSF DEB 1845845). Research questions are developed in order to have downstream impacts, informing natural resources managers, restorationists, farmers, agribusiness, and policy makers about microbially mediated ecosystem services such as improved water quality and climate change mitigation.

B. Positions and Honors

1. Positions and Employment

2003-2006 Research Assistant, Soil Ecology Laboratory, University of Illinois at Urbana-Champaign, Urbana, IL (UIUC)
2003-2005 Instructor in Natural Resources and Environmental Sciences, UIUC
2006-2007 Technician, Microbial Ecology Laboratory, UIUC
2007-2011 Research Assistant, Microbial Ecology Laboratory, UIUC
2008-2010 Instructor in Integrative Biology, UIUC
2011-2012 Postdoctoral Research Associate, Microbial Ecology and Agroecology, Kellogg Biological Station, Michigan State University, Hickory Corners, MI (MSU)
2012-2013 Postdoctoral Fellow, National Institute of Food and Agriculture Fellow, Microbial Ecology, Indiana University, Bloomington, IN
2012-2013 Visiting Research Associate, Kellogg Biological Station, MSU
2014-present Assistant Professor, Department of Biology, ECU
2014-2018 Visiting Assistant Professor, Kellogg Biological Station, MSU

2. Professional Memberships

2004-present Ecological Society of America
2006-present Soil Science Society of America
2017-present American Society for Microbiology

3. Professional Service (selected)

2016-2017 Secretary, Microbial Ecology Section, Ecological Society of America (elected)
2017-2018 Vice-Chair, Microbial Ecology Section, Ecological Society of America (elected)
2018-2019 Chair, Microbial Ecology Section, Ecological Society of America (elected)
2018-2020 American Society for Microbiology MICROBE Program Planning Committee
2014-2019 National Science Foundation Proposal Panelist
2018-present Community engagement through ourNCwater Initiative hosted at ECU's Center for Natural Hazards Research. Interdisciplinary research team facilitates the monitoring and analyses of drinking ground water quality currently focused in Eastern North Carolina.

4. Honors

2017 East Carolina University Coastal Maritime Council Coastal Scholar Award
2018 East Carolina University 2017-2018 Scholar-Teacher Award

C. Contributions to Science

1. Microbial-Climate Change Feedbacks on Ecosystem Functions

Prior land use can result in permanent changes in microbial community structure and function. These legacy effects can constrain responses to the current environment. My research has and continues to document changes in microbial community composition and how nitrogen dynamics are dependent on prior environmental conditions. Other projects leverage ongoing urban restoration projects in support of understanding how our built environment can be managed to improve water resources quality. As urban development continues, it is increasingly important to examine how microbial ecology can inform restoration especially regarding nutrient cycling functions. Land use change results in tradeoffs between ecosystem services and dis-services. Selected peer-reviewed manuscripts (7 out of 15 total highlighted)

a. Sprunger, C., S.W. Culman, **A.L. Peralta**, S.T. DuPont, J.T. Lennon, and S.S. Snapp (2019) Perennial grain crop roots and nitrogen management shape soil food webs and soil carbon dynamics. Soil Biology & Biochemistry. 137.
b. **Peralta, A.L.**, Y. Sun, M.D. McDaniel and J.T. Lennon (2018) Crop rotational diversity increases disease suppressive capacity of soil microbiomes. Ecosphere. 9(5).
c. **Peralta, A.L**., M.E. Muscarella, and J.W. Matthews (2017) Wetland management strategies lead to tradeoffs in ecological structure & function. Elementa: Science of the Anthropocene. 5:74.
d. **Peralta, A.L.**, E.R. Johnston, J.W. Matthews, and A.D. Kent (2016) Abiotic correlates of microbial community structure and nitrogen cycling functions vary within wetlands. Freshwater Science. 35(2):573–588.
e. **Peralta, A.L.**, D. Stuart, A.D. Kent, and J.T. Lennon (2014) A social-ecological framework for 'micromanaging' microbial services. Frontiers in Ecology and the Environment. 12(9):524–531.
f. **Peralta, A.L.**, S. Ludmer, and A.D. Kent (2013) Hydrologic history constrains microbial community composition and nitrogen cycling under experimental drying/wetting treatments. Soil Biology & Biochemistry 66:29-37.
g. **Peralta, A.L.**, J.W. Matthews, D.N. Flanagan, and A.D. Kent (2012) Environmental factors at dissimilar spatial scales influence plant and microbial communities in restored wetlands. Wetlands 32:1125-1134.

2. Complete List of Published Work in Bibliography:

https://scholar.google.com/citations?hl=en&user=EqAPmLQAAAAJ&view_op=list_works&sortby=pubdate

D. Additional Information: Research Support and/or Scholastic Performance

1. National Science Foundation (DEB 1845845, PI: Peralta) 2019-2024

CAREER: Microbial controls on wetland carbon stabilization and storage

2. National Science Foundation (DRMS 1902282, Co-PI: Peralta) 2018-2019

2018 Hurricane Season: RAPID: Rural residents' self-protections to perceived and actual contamination risk in private drinking wells after Hurricane Florence

3. US Environmental Protection Agency STAR (RD836942, Co-PI: Peralta) 2017-2020

Community-level Management of Human Health Risks from Concentrated Animal Feeding Operations (CAFOs) with Defensive Natural Capital Investments

DEPARTMENT OF HEALTH AND HUMAN SERVICES
DIVISION OF PUBLIC HEALTH

ROY COOPER
GOVERNOR

MANDY COHEN, MD, MPH
SECRETARY

MARK BENTON
ACTING DIRECTOR

September 3, 2019

To: EPA "Contaminated Sites, Natural Disasters, Changing Environmental Conditions and Vulnerable Communities: Research to Build Resilience" STAR Program

From: Wilson Mize, Regional Environmental Health Specialist Well Program, North Carolina Division of Public Health, On-Site Water Protection Branch.

As a regional environmental health specialist, I assist in the development and implementation of statewide regulations and oversee the inspection and testing of private wells. I work directly with local county health officials, and the North Carolina Division of Public Health (NCDPH) works to promote and contribute to the highest possible level of health for the people of North Carolina. The On-Site Water Protection Branch is responsible for providing regulatory oversight of sub-surface on-site wastewater treatment and dispersal systems, as well as inspection and testing of private drinking water wells constructed, repaired or abandoned, on or after July 1, 2008.

This program is a joint effort among the local health departments and the On-Site Water Protection Branch. To carry out this mission, the Branch provides statewide regulatory and consultative services related to both the wastewater and private drinking water wells to local health departments and numerous other clients, including builders, developers, land owners, system installers, well drillers, system operators, engineers, soil scientists, geologists, environmental health consultants and others.

I am pleased to write this letter to support the proposal titled "Predicting Drinking Water Contamination from Extreme Weather to Reduce Early Life Contaminant Exposures" by facilitating introductions with the research team and county health officials statewide. As an organizer of North Carolina's annual Environmental Health Symposium, which brings together county health officials and private well specialists, we intend to invite the research team to discuss their planned work in August 2020. Our office is also pleased to provide expertise to researchers seeking to understand risk factors associated with contamination in aging well systems. Therefore, I fully support your STAR Program proposal and will provide technical assistance when needed.

Sincerely,

Wilson Mize

Wilson Mize
Regional Environmental Health Specialist
On-Site Water Protection Branch
NC DHHS/Division of Public Health

North Carolina Health and Human Services

North Carolina State Center for Health Statistics

Via Electronic Mail

September 27, 2019

To: EPA "Contaminated Sites, Natural Disasters, Changing Environmental Conditions and Vulnerable Communities: Research to Build Resilience" STAR Program

From: Sidney Evans, Statistician, North Carolina State Center for Health Statistics

Re: Letter of Support for US EPA STAR Proposal

The North Carolina State Center for Health Statistics is responsible for data collection, health-related research, and production of reports and maintenance of a comprehensive collection of health statistics. We provide high quality health information for better informed decisions and effective health policies. Our goal is to improve the health of all North Carolinians and their communities. We are pleased to support the proposal titled "Predicting Drinking Water Contamination from Extreme Weather to Reduce Early Life Contaminant Exposures" by providing vital statistics data that are publicly available upon request relating to infant mortality, births, deaths and fetal deaths.

If you have any questions regarding the data services that are provided by the North Carolina State Center for Health Statistics, please do not hesitate to contact me.

Sid Evans

Sid Evans

Statistician
Division of Public Health, State Center for Health Statistics
North Carolina Department of Health and Human Services

919-715-4571 office
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Sidney.Evans@dhhs.nc.gov

222 N. Dawson street
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Raleigh, NC 27699

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
LINDA CULPEPPER
Director

NORTH CAROLINA
Environmental Quality

September 27, 2019

Dr. Jacob Hochard
Assistant Professor of Economics
Assistant Research Scientist, Coastal Studies Institute
East Carolina University
1000 E. 5th Street
Greenville, NC 27858

Re: US EPA STAR Proposal:

The North Carolina Department of Environmental Quality's Division of Water Resources ensures safe drinking water in accordance with federal requirements, issues pollution control permits, monitors permit compliance, evaluates environmental water quantity and quality, and carries out enforcement actions for violations of environmental regulations. We are pleased to provide this letter of support for the research project titled "Predicting Drinking Water Contamination from Extreme Weather to Reduce Early Life Contaminant Exposures" that you intend to submit to the U.S. Environmental Protection Agency's Science to Achieve Results Request for Proposals entitled "Contaminated Sites, Natural Disasters, Changing Environmental Conditions and Vulnerable Communities: Research to Build Resilience". The monitoring of private wells in our state is conducted primarily by counties that often have constrained financial and human resources. Big data approaches that improve targeting of private well testing and monitoring has the potential to create a useful partnership between county health offices, state enforcement and water planning agencies, and regional academic institutions that mitigates potential risks to human health from occurrences of groundwater contamination statewide.

We are pleased to have another opportunity to benefit from your research at East Carolina University to help us expand the State's capabilities to serve the North Carolina public, protect drinking water, and preserve water resources.

Best regards,

Craig Caldwell, P.G.
Program Consultant / Hydrogeologist, Water Planning Section
NC Department of Environmental Quality - Division of Water Resources
Email: craig.caldwell@ncdenr.gov
phone: 919-707-9112

Dr. Jacob Hochard
Assistant Professor of Economics
Assistant Research Scientist, Coastal Studies Institute
East Carolina University
1000 E. 5th Street
Greenville, NC 27858

Re: US EPA STAR Proposal

Dear Jake:

The North Carolina Agromedicine Institute ('the Institute') is pleased to provide this letter of support for the research project titled "Predicting Drinking Water Contamination from Extreme Weather to Reduce Early Life Contaminant Exposures" that you intend to submit to the U.S. Environmental Protection Agency's Science to Achieve Results Request for Proposals entitled "Contaminated Sites, Natural Disasters, Changing Environmental Conditions and Vulnerable Communities: Research to Build Resilience". The project aligns with the Institute's mission to promote the health and safety of farmers, fishermen, foresters, their workers and their families through research, prevention/intervention and education/outreach. These individuals primarily live and work in areas served by private wells and in areas that have been significantly affected by extreme weather conditions over the past several years. The proposed research is important to their wellbeing and that of future agricultural generations. The Institute looks forward to working with you as an Institute Member to assist with project logistics and with dissemination of findings through the Institute's website, Agricultural Health and Safety Symposium, professional meetings and other means.

Regards,

Robin Tutor-Marcom

Robin Tutor Marcom, EdD, MPH
Director
tutorr@ecu.edu

SOUND RIVERS
PROTECTING THE NEUSE & TAR-PAMLICO

September 29, 2019

Dr. Jacob Hochard
Assistant Professor of Economics
Assistant Research Scientist, Coastal Studies Institute
East Carolina University
1000 E. 5th Street
Greenville, NC 27858

Re: US EPA STAR Proposal

Dear Jake,

Sound Rivers is pleased to provide this letter of support for the research project titled "Predicting Drinking Water Contamination from Extreme Weather to Reduce Early Life Contaminant Exposures" that you intend to submit to the U.S. Environmental Protection Agency's Science to Achieve Results Request for Proposals entitled "Contaminated Sites, Natural Disasters, Changing Environmental Conditions and Vulnerable Communities: Research to Build Resilience". Sound Rivers is a private nonprofit organization that guards the health and natural beauty of the Neuse and Tar-Pamlico River Basins. Our goal is to provide clean water to our communities for consumption, recreation, nature preservation and agricultural use. The project's goal to bring awareness to potentially contaminated groundwater sources that might affect particularly vulnerable populations is therefore aligned with our own. Further, Sound Rivers has a vast network of non-profit partners across the state of North Carolina that may be able to support the proposed work in terms of (i) access to potentially-affected or target communities it that becomes a challenge or (ii) broadening the dissemination of findings within communities that may experience high rates of well contamination.

Best wishes for a successful submission.

Regards,

Heather Deck

Heather Deck
Executive Director
Sound Rivers, Inc.

Department of Geological Sciences
101 Graham Building | Mail Stop 558 | East Carolina University | Greenville, NC 27858-4353
252-328-6360 office | 252-328-4391 fax

Dr. Jacob Hochard
Assistant Professor of Economics
Assistant Research Scientist, Coastal Studies Institute
East Carolina University
1000 E. 5th Street
Greenville, NC 27858

Re: US EPA STAR Proposal

Dear Jake:

East Carolina University's Water Resources Center seeks to advance water-related research, education, and outreach in Eastern North Carolina. Center affiliates are finding ways to improve our understanding at the interface of human, natural and engineered systems to ensure a resilient and sustainable future for communities at home and around the world. A core emphasis of the Center is data-driven decision making. This work ranges from developing artificial intelligence tools to synthesize complex data sets obtained from innovative new sensing platforms to building programs for students and the public to become engaged stewards of their water resources. As such, the proposed project entitled "Predicting Drinking Water Contamination from Extreme Weather to Reduce Early Life Contaminant Exposures" for submission to the US Environmental Protection Agency's Science to Achieve Results (STAR) Request for Proposals "Contaminated Sites, Natural Disasters, Changing Environmental Conditions and Vulnerable Communities: Research to Build Resilience" is expressly aligned with the mission of our Center.

I offer the full support of the Water Resources Center to enable the proposed work, including use of our personnel and resources to facilitate the activities of the project.

Regards,

Dr. Stephen Moysey
Director, ECU Water Resources Center
Professor, Geological Sciences
MOYSEYS18@ECU.EDU

Natural Resources and the Environment Research Cluster
Division of Research, Economic Development and Engagement
2900 Greenville Centre | 2200 S. Charles Boulevard | Mail Stop 211
East Carolina University | Greenville, NC 27858-4353 | https://rede.ecu.edu
Alex Manda, Co-Director, mandaa@ecu.edu
Burrell Montz, Co-Director, montzb@ecu.edu

Dr. Jacob Hochard
Assistant Professor of Economics
Assistant Research Scientist, Coastal Studies Institute
East Carolina University
1000 E. 5th Street
Greenville, NC 27858

Re: US EPA STAR Proposal

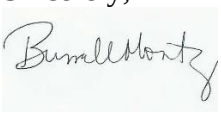
Dear Jake:

East Carolina University's Natural Resources and the Environment Research Cluster focuses on discovering new ways to support and optimize sustainable use of our natural resources and the environment. The cluster places an emphasis on water quality and quantity issues in eastern North Carolina. As such, the proposed project entitled **"Predicting Drinking Water Contamination from Extreme Weather to Reduce Early Life Contaminant Exposures"** for submission to the US Environmental Protection Agency's Science to Achieve Results (STAR) Request for Proposals "Contaminated Sites, Natural Disasters, Changing Environmental Conditions and Vulnerable Communities: Research to Build Resilience" is expressly aligned with the following short-term and long-term goals of our research cluster:

- Develop relationships with potential collaborators within and outside ECU that lead energy and natural resources research projects
- Identify research opportunities that connect to community and regional needs
- Initiate projects that focus on biogas, water resources and other areas in the natural resources and energy area

We offer our full support for the proposed work and wish you the best for a successful submission.

Sincerely,



Burrell Montz
Professor of Geography

Alex Manda
Associate Professor of Geological Sciences

Co-Directors, Natural Resources and the Environment Research Cluster

Name of Investigator: Walter “Scott” Curtis

Contact: wcurtis1@citadel.edu, (843) 953-6781

Subcontract recipient: The Citadel (Charleston, SC)

OSP contact: Leigh Lipscomb, leigh.lipscomb@citadel.edu; (843) 953-3184

Statement of Work:

Dr. Curtis will lead the synthesis of historical and spatially-explicit precipitation and temperature data into the econometric modeling of well contamination risk. He will also lead the synthesis of the spatial data for the hydrological modeling.

Budget:

See additional document.

Budget Justification:

See additional document.

East Carolina University Statement of Work

Project Title: Predicting Drinking Water Contamination from Extreme Weather to Reduce Early Life Contaminant Exposures
Lead Institution: University of Wyoming
Lead Investigator: Dr. Jake Hochard

Overview

Private wells are the drinking water source for over 43 million U.S. households but remain unregulated federally and are vulnerable to contamination from environmental hazards. Over 2 million North Carolina residents use wells in areas prone to hurricanes and floods, which can increase chemical and biological contamination (e.g., pathogenic bacteria). Households near contaminated sites, such as animal feeding operations, hazardous waste and coal ash facilities are especially vulnerable to upgradient contaminants, which can be intensified by air temperature and precipitation trends. No mechanism exists for predicting contamination events and informing a cost-effective and human health-preserving intervention. Yet, large-scale and fine-resolution datasets, from federal, state and local agencies, have the potential to capture the complex human and physico-chemical interactions that predict contamination. Developing novel quantitative approaches that synthesize large and disparate data sets is critical to guiding interventions that could be used by local health offices to prevent early life exposures that impair cognitive development. East Carolina University (ECU) is partnering with a team from University of Wyoming and The Citadel on this project. The following statement of work describes the role that ECU faculty David Collier, Randall Etheridge, Jamie Kruse, and Ariane Peralta will play in the project.

Statement of Work

- Hydrological modeling

The ECU research team will couple the watershed-scale SWAT+ model (Bieger et al., 2017) with the groundwater model MODFLOW (Hughes et al., 2017). The SWAT+ model simulates water and contaminant transport at or near the surface. Coupling SWAT+ with MODFLOW will allow us to simulate the transport of contaminants from their source at the surface to the wells that are the source of drinking water (Bailey et al., 2016). Creating a coupled SWAT+MODFLOW model for all of North Carolina is outside the scope of this project. For this project, we will calibrate and validate the coupled model for the Cape Fear River watershed in North Carolina. The Cape Fear River watershed was chosen because it is the location of our current groundwater contamination projects, which reduces the amount the data collection required to begin running the model. If calibration and validation is successful in this watershed and the coupled hydrological model enhances our warning system, the model can be expanded to other areas in the future.

We will use existing monitoring data and information from a previously calibrated MODFLOW model of the area to begin calibration and validation (Coes et al, 2016). The flow and water quality parameters in the SWAT+ model will be calibrated using flow data from the USGS gauge stations in the watershed and using water quality data from the NC Department of Environmental Quality Ambient Monitoring System. Coes and others (2016) led an effort to calibrate and validate a MODFLOW model in portions of North Carolina, South Carolina, Georgia, and Virginia. The data and model parameters developed from the effort by Coes and others will be updated and used for this project. Updated water level data will come from the NC Department of Environmental Quality Division of Water Resources groundwater monitoring network. Data from our previous projects on contaminant sources and groundwater quality will be used for calibrating and validating the groundwater solute transport simulator. Separate periods of at least 5 years will be used for calibration and validation of the coupled model.

- Targeted human health interventions and well water testing

In partnership with collaborators at the University of Wyoming, we will coordinate with North Carolina Department of Health and Human Services (NC DHHS) to design outreach material that satisfies the standards of the University of Wyoming graphic designer, our team's pediatrician and the NC DHHS On-Site Water Protections Branch. Such a coordination will ensure the risk notification is acceptable to county public health departments, accessible to the general public and medically appropriate for public dissemination. The "risk messenger" of material will be assigned randomly for each new notification as either our team's pediatrician or the home county's public health department. In both cases, the risk notification material will offer free water testing to be conducted by the home county's health department and paid for, under this award, by ECU.

- Support econometric analysis and project management

The University of Wyoming will lead both the econometric analysis and the project management. The project team at ECU will support both tasks. The ECU team will specifically be responsible for synthesis of statewide soil mapping data and supervising the technician hired to support hydrological modeling.

References

Bailey, R.T., T.C. Wible, M. Arabi, R.M. Records, and J. Ditty. 2016. Assessing regional-scale spatio-temporal patterns of groundwater–surface water interactions using a coupled SWAT-MODFLOW model. Hydrological Processes 30(23): 4420–4433. doi: 10.1002/hyp.10933.

Bieger, K., J.G. Arnold, H. Rathjens, M.J. White, D.D. Bosch, et al. 2017. Introduction to SWAT+, A Completely Restructured Version of the Soil and Water Assessment Tool. JAWRA Journal of the American Water Resources Association: 115–130. doi: 10.1111/1752-1688.12482@10.1111/(ISSN)17521688/SWAT.

Coes, A.L., B.G. Campbell, M.D. Petkewich, and J.M. Fine. 2016. MODFLOW2000 and MODFLOW-ASP models used to simulate the groundwater flow in the Atlantic Coastal Plain, North and South Carolina and parts of Georgia and Virginia, Predevelopment to 2004. http://dx.doi.org/10.5066/F7RJ4GJF.

Hughes, J.D., Langevin, C.D., and Banta, E.R., 2017, Documentation for the MODFLOW 6 framework: U.S. Geological Survey Techniques and Methods, book 6, chap. A57, 40 p., https://doi.org/10.3133/tm6A57.

Office of Research Administration
Division of Research, Economic Development & Engagement
209 East 5th Street
Mail Stop 211
Greenville, NC 27858-1821
252-328-9530 office | www.ecu.edu/rede

September 1, 2020

Ms. Shauna Bury
Assistant Director Research Services
University of Wyoming
Office of Vice President for Research
1000 E. University Avenue, Dept. 3355
Laramie, WY 82071

OFFICIAL LETTER OF INTENT

Dear Ms. Bury:

East Carolina University is pleased to endorse the following proposal enclosed for your review.

Proposal Information
Investigator/Project Director: Dr. Randall Ethridge
Project Title: Predicting Drinking Water Contamination from Extreme Weather to Reduce Early Life Contaminant Exposures
Project Budget: $403,879
Project Dates: September 1, 2020 thru August 31, 2023

Legal Identity
East Carolina University ("ECU") is an agency or instrumentality of the State of North Carolina and a constituent institution of the University of North Carolina System. All grant and contract awards and agreements must be executed by an authorized official of ECU. Individuals, Departments, Colleges, and Centers may not directly enter into sponsored research agreements that legally bind ECU.

The Office of Research Administration is the official channel through which East Carolina University faculty conduct all business with external research sponsors. It has administrative responsibility during the preparation and submission of proposals as well as throughout the duration of subsequent awards. All proposals to external funding sources for sponsored projects must be submitted through the Office of Research Administration and all awards and agreements for sponsored projects must be processed through the Office of Research Administration. Therefore, I would appreciate copies of correspondence with the Project Director pertaining to administrative and financial matters concerning this project.

Proposal Submittal
The appropriate programmatic and administrative personnel of each institution involved in this grant application are aware of the prime sponsor's grants policy and will establish the necessary inter-institutional agreement(s) consistent with that policy. As a consortium partner, East Carolina University agrees to provide the services defined in the above referenced proposal in accordance with the attached

budget and scope of work.

East Carolina University certifies that at the time of submission neither it nor its principals are presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.

East Carolina University reserves the right to negotiate the terms and conditions of any awarded grant or contract. As an agency or instrumentality of the State of North Carolina and an educational institution, if conducting fundamental or applied research under the awarded grant or contract, East Carolina University reserves the right to (i) require that the provider notify East Carolina University if it intends to or will provide any export controlled information or materials under the resulting grant or contract; (ii) deny receipt of any export controlled materials or information; (iii) reject any restrictions on East Carolina University's right to publish or otherwise disseminate information relating to the research; (iv) reject any provisions or clauses that implicate, impede, or contravene East Carolina University's rights, privileges, and immunities under applicable state law.

The Office of Research Administration is pleased to assist our faculty and external sponsors in any matter. Accordingly, if questions arise, please contact (252) 328-9530 or e-mail ora@ecu.edu.

Sincerely,

Digitally signed by
Mary Lisa Pories
Date: 2020.09.01
16:02:42 -04'00'

Mary Lisa Pories
Sponsored Programs Officer
Office of Research Administration

Enclosures:
Proposal Statement of Work
Proposal Budget
Proposal Budget Justification

East Carolina University Investigators

Project Title: Predicting Drinking Water Contamination from Extreme Weather to Reduce Early Life Contaminant Exposures
Lead Institution: University of Wyoming
Lead Investigator: Dr. Jake Hochard

Faculty

1. Dr. Randall Etheridge (ECU lead) – Department of Engineering and Center for Sustainable Energy and Environmental Engineering
2. Dr. David Collier – Department of Pediatrics
3. Dr. Jamie Kruse – Department of Economics and Center for Natural Hazards Research
4. Dr. Ariane Peralta – Department of Biology

Contact Information for ECU Lead

Randall Etheridge
Mail Stop 117
Department of Engineering, East Carolina University
Greenville, NC 27858
etheridgej15@ecu.edu
252-737-1930

U.S. ENVIRONMENTAL PROTECTION AGENCY
Washington, DC 20460

Preaward Compliance Review Report for All Applicants and Recipients Requesting EPA Financial Assistance

Note: Read instructions on other side before completing form.

I. Applicant/Recipient (Name, Address, State, Zip Code).	DUNS No.
University of Wyoming	069690956

II. Is the applicant currently receiving EPA assistance?

Yes

III. List all civil rights lawsuits and administrative complaints pending against the applicant/recipient that allege discrimination based on race, color, national origin, sex, age, or disability. (Do not include employment complaints not covered by 40 C.F.R. Parts 5 and 7. See instructions on reverse side.)

IV. List all civil rights lawsuits and administrative complaints decided against the applicant/recipient within the last year that allege discrimination based on race, color, national origin, sex, age, or disability and enclose a copy of all decisions. Please describe all corrective action taken. (Do not include employment complaints not covered by 40 C.F.R. Parts 5 and 7. See instructions on reverse side.)

V. List all civil rights compliance reviews of the applicant/recipient conducted by any agency within the last two years and enclose a copy of the review and any decisions, orders, or agreements based on the review. Please describe any corrective action taken. (40 C.F.R. § 7.80(c)(3))

VI. Is the applicant requesting EPA assistance for new construction? If no, proceed to VII; if yes, answer (a) and/or (b) below. ✓

a. If the grant is for new construction, will all new facilities or alterations to existing facilities be designed and constructed to be readily accessible to and usable by persons with disabilities? If yes, proceed to VII; if no, proceed to VI(b).
b. If the grant is for new construction and the new facilities or alterations to existing facilities will not be readily accessible to and usable by persons with disabilities, explain how a regulatory exception (40 C.F.R. § 7.70) applies.

VII. Does the applicant/recipient provide initial and continuing notice that it does not discriminate on the basis of race, color, national origin, sex, age, or disability in its programs or activities? (40 C.F.R. § 5.140 and § 7.95) ✓

a. Do the methods of notice accommodate those with impaired vision or hearing? ✓
b. Is the notice posted in a prominent place in the applicant's offices or facilities or, for education programs and activities, in appropriate periodicals and other written communications? ✓
c. Does the notice identify a designated civil rights coordinator? ✓

VIII. Does the applicant/recipient maintain demographic data on the race, color, national origin, sex, age, or handicap of the population it serves? (40 C.F.R. § 7.85(a)) Yes

IX. Does the applicant/recipient have a policy/procedure for providing access to services for persons with limited English proficiency? (40 C.F.R. Part 7, E.O. 13166) Yes

X. If the applicant/recipient is an education program or activity, or has 15 or more employees, has it designated an employee to coordinate its compliance with 40 C.F.R. Parts 5 and 7? Provide the name, title, position, mailing address, e-mail address, fax number, and telephone number of the designated coordinator. Emily A. Monago, Chief Diversity Officer, Office of Diversity, Equity

XI. If the applicant/recipient is an education program or activity, or has 15 or more employees, has it adopted grievance procedures that assure the prompt and fair resolution of complaints that allege a violation of 40 C.F.R. Parts 5 and 7? Provide a legal citation or Internet address for, or a copy of, the procedures. http://www.uwyo.edu/diversity/

For the Applicant/Recipient

I certify that the statements I have made on this form and all attachments thereto are true, accurate and complete. I acknowledge that any knowingly false or misleading statement may be punishable by fine or imprisonment or both under applicable law. I assure that I will fully comply with all applicable civil rights statutes and EPA regulations.

A. Signature of Authorized Official	B. Title of Authorized Official	C. Date
	Associate Vice President for Research	September 9, 2020

For the U.S. Environmental Protection Agency

I have reviewed the information provided by the applicant/recipient and hereby certify that the applicant/recipient has submitted all preaward compliance information required by 40 C.F.R. Parts 5 and 7; that based on the information submitted, this application satisfies the preaward provisions of 40 C.F.R. Parts 5 and 7; and that the applicant has given assurance that it will fully comply with all applicable civil rights statutes and EPA regulations.

A. Signature of Authorized EPA Official	B. Title of Authorized EPA Official	C. Date
See * note on reverse side		

Instructions for EPA FORM 4700-4 (Rev. 06/2014)

General

Recipients of Federal financial assistance from the U.S. Environmental Protection Agency must comply with the following statutes and regulations.

Title VI of the Civil Rights Acts of 1964 provides that no person in the United States shall, on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance. The Act goes on to explain that the statute shall not be construed to authorize action with respect to any employment practice of any employer, employment agency, or labor organization (except where the primary objective of the Federal financial assistance is to provide employment).

Section 13 of the 1972 Amendments to the Federal Water Pollution Control Act provides that no person in the United States shall on the ground of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under the Federal Water Pollution Control Act, as amended. Employment discrimination on the basis of sex is prohibited in all such programs or activities.

Section 504 of the Rehabilitation Act of 1973 provides that no otherwise qualified individual with a disability in the United States shall solely by reason of disability be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance. Employment discrimination on the basis of disability is prohibited in all such programs or activities.

The Age Discrimination Act of 1975 provides that no person on the basis of age shall be excluded from participation under any program or activity receiving Federal financial assistance. Employment discrimination is not covered. Age discrimination in employment is prohibited by the Age Discrimination in Employment Act administered by the Equal Employment Opportunity Commission.

Title IX of the Education Amendments of 1972 provides that no person in the United States on the basis of sex shall be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance. Employment discrimination on the basis of sex is prohibited in all such education programs or activities. Note: an education program or activity is not limited to only those conducted by a formal institution.

40 C.F.R. Part 5 implements Title IX of the Education Amendments of 1972.

40 C.F.R. Part 7 implements Title VI of the Civil Rights Act of 1964, Section 13 of the 1972 Amendments to the Federal Water Pollution Control Act, and Section 504 of The Rehabilitation Act of 1973.

The Executive Order 13166 (E.O. 13166) entitled; "Improving Access to Services for Persons with Limited English Proficiency" requires Federal agencies work to ensure that recipients of Federal financial assistance provide meaningful access to their LEP applicants and beneficiaries.

Items

"Applicant" means any entity that files an application or unsolicited proposal or otherwise requests EPA assistance. 40 C.F.R. §§ 5.105, 7.25.

"Recipient" means any entity, other than applicant, which will actually receive EPA assistance. 40 C.F.R. §§ 5.105, 7.25.

"Civil rights lawsuits and administrative complaints" means any lawsuit or administrative complaint alleging discrimination on the basis of race, color, national origin, sex, age, or disability pending or decided against the applicant and/or entity which actually benefits from the grant, but excluding employment complaints not covered by 40 C.F.R. Parts 5 and 7. For example, if a city is the named applicant but the grant will actually benefit the Department of Sewage, civil rights lawsuits involving both the city and the Department of Sewage should be listed.

"Civil rights compliance review" means any review assessing the applicant's and/or recipient's compliance with laws prohibiting discrimination on the basis of race, color, national origin, sex, age, or disability.

Submit this form with the original and required copies of applications, requests for extensions, requests for increase of funds, etc. Updates of information are all that are required after the initial application submission.

If any item is not relevant to the project for which assistance is requested, write "NA" for "Not Applicable."

In the event applicant is uncertain about how to answer any questions, EPA program officials should be contacted for clarification.

* Note: Signature appears in the Approval Section of the EPA Comprehensive Administrative Review For Grants/Cooperative Agreements & Continuation/Supplemental Awards form.

"Burden Disclosure Statement"

EPA estimates public reporting burden for the preparation of this form to average 30 minutes per response. This estimate includes the time for reviewing instructions, gathering and maintaining the data needed and completing and reviewing the form. Send comments regarding the burden estimate, including suggestions for reducing this burden, to U.S. EPA, Attn: Collection Strategies Division (MC 2822T), Office of Information Collection, 1200 Pennsylvania Ave., NW, Washington, D.C. 20460; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, D.C. 20503.

The information on this form is required to enable the U.S. Environmental Protection Agency to determine whether applicants and prospective recipients are developing projects, programs and activities on a nondiscriminatory basis as required by the above statutes and regulations.

Principal Investigator/Program Director (Last, First, Middle): Scott Curtis

CHECKLIST

TYPE OF APPLICATION *(Check all that apply.)*

NEW application. *(This application is being submitted to the PHS for the first time)*

RESUBMISSION of application number:

(This application replaces a prior unfunded version of a new, competing continuation, or supplemental application)

RENEWAL of grant number:

(This application is to extend a funded grant beyond its current project period.)

SUPPLEMENT/REVISION to grant number:

(This application is for additional funds to supplement a currently funded grant.)

INVENTIONS AND PATENTS
(Competing continuation appl. and Phase II only)

No

Yes. If "Yes," Previously reported

Not previously reported

CHANGE of principal investigator/program director.

Name of former principal investigator/program director:

CHANGE of Grantee Institution. Name of former institu ion:

FOREIGN application Domestic Grant with foreign involvement List Country(ies) Involved:

. PROGRAM INCOME *(See instructions.)*

All applications must indicate whether program income is an icipated during the period(s) for which grant support is requested. If program income is anticipated, use the format below to reflect the amount and source(s).

Budget Period	Anticipated Amount	Source(s)

2. ASSURANCES/CERTIFICATIONS (see instructions.)

In signing the application Face Page, the authorized organizational representative agrees to comply with the following policies, assurances and/or certification when applicable. Descriptions of individual assurances/certifications are provided in Part III. If unable to certify compliance, where applicable, provide an explanation and place it after this page.
•Human Subjects; •Research Using Human Embryonic Stem Cells• •Research on Transplantation of Human Fetal Tissue •Women and Minority Inclusion Policy •Inclusion of Children Policy• Vertebrate Animals• •Debarment and Suspension •Drug-Free Workplace (applicable to new [Type 1] or revised/resubmission [Type 1] applications only) •Lobbying •Non-Delinquency on Federal Debt •Research Misconduct •Civil Rights (Form HHS 441 or HHS 690) •Handicapped Individuals (Form HHS 641 or HHS 690) •Sex Discrimination (Form HHS 639-A or HHS 690) •Age Discrimination (Form HHS 680 or HHS 690) •Recombinant DNA Research, Including Human Gene Transfer Research •Financial Conflict of Interest •Smoke Free Workplace •Prohibited Research •Select Agent Research •PI Assurance

3. FACILITIES AND ADMINISTRATION COSTS (F & A)/ INDIRECT COSTS. See specific instructions.

DHHS Agreement dated: November 5, 2012

No Facilities & Administrative Costs Requested.

DHHS Agreement being negotiated with Regional Office.

No DHHS Agreement, but rate established with Date

CALCULATION* *(The entire grant application, including the Checklist, will be reproduced and provided to peer reviewers as confidential information.)*

a. Initial budget period	Amount of base $	$10,425	x Rate applie	(b) (6)	= F&A costs	(b) (6)
b. 02 year	Amount of base $	$10,738	x Rate applie		= F&A costs	
c. 03 year	Amount of base $	$11,060	x Rate applie		= F&A costs	
d. 04 year	Amount of base $	#REF!	x Rate applie		= F&A costs	
e. 05 year	Amount of base $	#REF!	x Rate applie		= F&A costs	

L F&A Costs #

*Check appropriate box(es):

Salary and wages base

Modified total direct cost base

Other base *(Explain)*

Off-site, other special rate, or more than one rate involved *(Explain)*

Explanation *(Attach separate sheet, if necessary):*

IRB Authorization Agreement

Name of Institution or Organization Providing IRB Review (Institution A): East Carolina University, University and Medical Center Institutional Review Board (UMCIRB)

IRB Registration #: 00000705
Federal wide Assurance (FWA) #, if any: 00000658

Name of Institution Relying on the Designated IRB (Institution B): University of Wyoming
OHRP Federal wide Assurance (FWA) #: 00000186

The Officials signing below agree that Institution B may rely on the designated IRB for review and continuing oversight of its human subject research described below: (choose one)

(___) This agreement applies to all human subject research covered by Institution B's FWA.

(x) This agreement is limited to the following specific protocol(s):
Name of Research Project: Community-level Management of Human Health Risks from Concentrated Animal Feeding Operations (CAFOs) with Defensive Natural Capital Investments
Name of Institution A's Principal Investigator: Jacob Hochard, PhD
IRB Study Number: 17-000354
External IRB Study Number (if any): _____
Sponsor or Funding Agency: Environmental Protection Agency
Award Number, if any: _____

(___) Other (describe):

The Reviewing Institution's IRB agrees to the following in regard to the above listed research protocol or activities:

I. Provide initial and continuing review in accordance with 45 CFR 46 and its FWA.

II. Arrange for prompt reporting to the Relying Institution's IRB of any of the following, as defined and determined by the Reviewing Institution's IRB:

    a. Any unanticipated events or problems involving risks to subjects or others.

    b. Any serious or continuing non-compliance. Any suspension or termination of IRB approval.

III. Comply will all applicable Federal, State and Local laws and regulations.

IV. IRB meeting minutes will be made available to the Relying Institution's IRB upon request.

V. Copy the Relying Institution on all correspondence to regulatory agencies if reporting of an event is required.

The Relying Institution remains responsible for the following:

I. Ensuring research activities at its site are in compliance with the IRB's determinations and with the terms of its OHRP-approved Assurance.

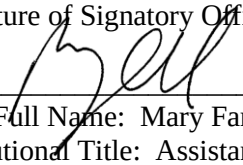
II. Adhering to its institutional conflict of interest policies and procedures and providing the Reviewing Institution with any applicable COI management plan related to the study.

III. Ensuring principal investigators and other research personnel involved in the research are appropriately qualified and meet its institutional standards for eligibility to conduct research, including, but is not limited to, having the required professional staff appointments, credentialing, insurance coverage, and background checks for their assigned role in the research and training in the protection of human subjects.

IV. Maintaining, implementing or have access to a human subjects research post approval monitoring (PAM) process, function, program or service not directly involved with the research that can conduct and report the results of for-cause and not-for-cause audits of the research study listed above to ensure compliance with human subject's protections regulations and other relevant requirements. The PAM process, function, program or service must monitor the conduct of research under this Agreement and ensure any relevant findings are reported to the Reviewing Institution.

This document must be kept on file at both institutions and provided to OHRP upon request. This agreement will become effective upon the date of the last signature by the institutional officials below and will remain in effect until such time that either institution provides 30 days written notice of termination to the other institution.

Signature of Signatory Official (Institution A):



_____ Date: _09/23/2020_

Print Full Name: Mary Farwell, PhD
Institutional Title: Assistant Vice Chancellor for Research, and Institutional Official

Signature of Signatory Official (Institution B):

_____ Date: __9-21-20_____

Print Full Name: Diana G. Hulme
Institutional Title: Associate Vice President of Research

Appendix A

Please provide the contact information for the individual at Institution A and Institution B who should be copied on all correspondence regarding the study.

Institution A:

Name: Suzanne Sparrow

Institutional Title: Director, Human Subjects Protections

Address:
University & Medical Center Institutional Review Board
East Carolina University
Brody Medical Sciences Building, Room 4N-70
Mailstop 682
Greenville, NC 27834

Email: sparrows@ecu.edu

Phone Number: 252-744-1785

Institution B: University of Wyoming

Name: Nichole J. Person

Institutional Title: Research Compliance Coordinator

Address:

1000 E. University Avenue
Department 3355
Laramie, WY 82071

Email: njperson@uwyo.edu

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THE CITADEL
THE MILITARY COLLEGE OF SOUTH CAROLINA

OFFICE OF THE PROVOST AND DEAN OF THE COLLEGE

24 August 2020

Dr. Jacob Hochard
Knobloch Assistant Professor of Conservation Economics
Haub School of Environment and Natural Resources
University of Wyoming
1000 E. University Avenue
Laramie, WY 82071

OFFICIAL LETTER OF INTENT

Dear Dr. Hochard:

The Citadel is pleased to endorse the following proposal:

Proposal Information
Investigator/Project Director: Dr. Scott Curtis
Project Title: Predicting Drinking Water Contamination from Extreme Weather to Reduce Early Life Contaminant Exposures
Project Budget: $45,821
Project Dates: 09/01/2020 through 08/31/2023

Legal Identity
The Citadel is an agency or instrumentality of the State of South Carolina. All grant and contract awards and agreements must be executed by an authorized official of the Citadel. Individuals, Departments, Colleges, and Centers may not directly enter into sponsored research agreements that legally bind the Citadel.

Proposal Submittal
The appropriate programmatic and administrative personnel of each institution involved in this grant application are aware of the prime sponsor's grants policy and will establish the necessary inter-institutional agreement(s) consistent with that policy. As a consortium partner, the Citadel agrees to provide the services defined in the above referenced proposal in accordance with the provided budget and scope of work. The Citadel certifies that at the time of submission neither it nor its principals are presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.

The Citadel reserves the right to negotiate the terms and conditions of any awarded grant or contract. As an agency or instrumentality of the State of South Carolina and an educational institution, if conducting fundamental or applied research under the awarded grant or contract, the Citadel reserves

the right to (i) require that the provider notify the Citadel if it intends to or will provide any export controlled information or materials under the resulting grant or contract; (ii) deny receipt of any export controlled materials or information; (iii) reject any restrictions on the Citadel's right to publish or otherwise disseminate information relating to the research; (iv) reject any provisions or clauses that implicate, impede, or contravene the Citadel's rights, privileges, and immunities under applicable state law.

The Director of Grants at the Citadel Foundation is pleased to assist our faculty and external sponsors in any matter. Accordingly, if questions arise, please contact Ms. Leigh Lipscomb (leigh.lipscomb@citadel.edu) or me (dzimmer1@citadel.edu).

Sincerely,

BG Sally C. Selden, Ph.D., SPHR
Brigadier General, SCM
Provost and Dean

SCS/DZ/cd

United States
ENVIRONMENTAL PROTECTION AGENCY
Washington, DC 20460

OMB Control No. 2030-0020
Approval expires 04/30/2021

Current and Pending Support

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Jacob Hochard	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☑ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal: Predicting Drinking Water Contamination from Extreme Weather to Reduce Early Life

Source of Support: U.S. Environmental Protection Agency
Total Award Amount: $799,952.00 Total Award Period Covered: 10-1-202(to 9-30-2023
Location of Project: Laramie, Wyoming
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.9

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal: Establishing Interface Standards for Physical Exposure and Human Impacts Data Coll

Source of Support: National Science Foundation
Total Award Amount: $299,464.00 Total Award Period Covered: 9-1-2019 to 8-31-2021
Location of Project: Greenville, North Carolina
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.45

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal: RAPID: Rural residents' self-protections to perceived and actual contamination risk in p

Source of Support: National Science Foundation
Total Award Amount: $179,223.00 Total Award Period Covered: 12-15-2018 to 11-30-2020
Location of Project: Greenville, North Carolina
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.0

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal: Community-level Management of Human Health Risks from Concentrated Animal Feed

Source of Support: U.S. Environmental Protection Agency
Total Award Amount: $399,226.00 Total Award Period Covered: 8-1-2017 to 7-31-2021
Location of Project: Greenville, North Carolina
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr: 0.0

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal:

Source of Support:
Total Award Amount: Total Award Period Covered: to
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

OMB Number: 4040-0007
Expiration Date: 02/28/2022

ASSURANCES - NON-CONSTRUCTION PROGRAMS

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the awarding agency. Further, certain Federal awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.

2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the award; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.

3. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.

4. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.

5. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).

6. Will comply with all Federal statutes relating to nondiscrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C.§§1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U. S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee- 3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.

7. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

8. Will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

9. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327-333), regarding labor standards for federally-assisted construction subagreements.

10. Will comply, if applicable, with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).

12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593 (identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).

14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.

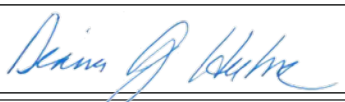
15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. §§2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.

16. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.

17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

19. Will comply with the requirements of Section 106(g) of the Trafficking Victims Protection Act (TVPA) of 2000, as amended (22 U.S.C. 7104) which prohibits grant award recipients or a sub-recipient from (1) Engaging in severe forms of trafficking in persons during the period of time that the award is in effect (2) Procuring a commercial sex act during the period of time that the award is in effect or (3) Using forced labor in the performance of the award or subawards under the award.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	TITLE
. 	Associate Vice President for Research
APPLICANT ORGANIZATION	DATE SUBMITTED
University of Wyoming	09/14/2020

University of Wyoming Budget

Total Salaries and Wages

EHRA Summer Compensation (3-months)	**Base Salary/Hourly Rate**	**% Effort Funded / Hours**	**Year 1**	**Year 2**	**Year 3**	**Total**
Jacob Hochard	(b) (6)	30.00%	(b) (6)	(b) (6)	(b) (6)	(b) (6)
Kayla Clark (incoming faculty spring 2021)	(b) (6)	25.00%	(b) (6)	(b) (6)	(b) (6)	(b) (6)
SHRA Staff						
Research Technician (Economic modeling)	(b) (6)	25.00%	(b) (6)	(b) (6)	(b) (6)	(b) (6)
PhD Student						
Department of Economics (12-months)	(b) (6)	12-month	(b) (6)	(b) (6)	(b) (6)	(b) (6)
Total Salaries and Wages			**$51,020**	**$52,551**	**$54,127**	**$157,698**
Fringe Benefits						
EHRA Summer Compensation			(b) (6)	(b) (6)	(b) (6)	(b) (6)
SHRA/CSS Staff			(b) (6)	(b) (6)	(b) (6)	(b) (6)
PhD Student			(b) (6)	(b) (6)	(b) (6)	(b) (6)
Total Fringe Benefits			**$11,411**	**$11,753**	**$12,105**	**$35,269**
Total Salaries Wages and Fringe			***$62,431***	***$64,303***	***$66,233***	***$192,966***
Total Supplies						
Community Engagement and Supplies			$1,500	$1,500	$1,500	$4,500
Total Travel						
Domestic Travel			$1,200	$0	$1,200	$2,400
Other Costs						
Computer Supplies			$7,000			$7,000
Tuition and Fees (F&A Exempt)			**$9,408**	**$9,690**	**$9,981**	**$29,079**
Summary						
Subawards						
ECU (subcontract 1)			**$131,869**	**$134,131**	**$137,879**	**$403,879**
The Citadel (subcontract 2)			**$14,824**	**$15,269**	**$15,728**	**$45,821**
Total Direct Costs			**$228,232**	**$224,894**	**$232,520**	**$685,646**
Total Modified Direct Costs (F&A Base)			**$111,955**	**$75,979**	**$68,933**	**$256,866**
Total Indirect Costs (44.5%)			**$49,820**	**$33,811**	**$30,675**	**$114,306**
Total Requested - U Wy (lead institution)			**$278,052**	**$258,705**	**$263,195**	**$799,952**
Total Direct Costs - ECU			$89,403	$91,254	$93,159	$273,816
Total Direct Costs - The Citadel			$10,425	$10,738	$11,060	$32,223
Total Indirect Costs - ECU			$42,466	$43,346	$44,251	$130,063
Total Indirect Costs - The Citadel			$4,399	$4,531	$4,667	$13,598
Fringe Benefits Broken out for EHRA						
Jacob Hochard			$4,758	$4,901	$5,048	$14,707
Kayla Clark (incoming faculty spring 2021)			$1,691	$1,742	$1,794	$5,226

A. Salaries and wages - Note that a 3% inflationary increase in salary is calculated for each year

1. *Lead-PI Dr. Jacob Hochard* 30% summer support for each year. In addition to project administration, Dr. Hochard will lead the econometric analysis and machine learning prediction of potentially contaminated water wells. Hochard will oversee the research tech focused on data synthesis and programming. Dr. Hochard will also oversee the PhD student who will be supporting the econometric analysis. Hochard will maintain the dedicated project website and lead the construction of technical reports.
2. *Co-PI Kayla Clark* 25% summer support. Ms. Clark will lead the design of risk communication materials to at-risk households with newborns. Clark will also lead community-level scientific communication by designing outreach publications and technical reports.
3. Other Personnel: (a) *Ph.D. student in Department of Economics)* will support hydrologic and econometric modeling. The student will assist with technical reports and publications and help coordinate with contacts at the Cape Fear River Watch and local health officials. *(b) Research technician in Haub School of Environment and Natural Resources* will support data synthesis and econometric modeling to predict well water contamination risks.

Position/Title	12 mo Salary*	Perc. of 12-Month Annual Effort Assigned to Project*	Cost Yr1	Cost Yr2	Cost Yr3	TOTAL
PI Hochard, Asst Prof	(b) (6)	0.10 academic year, Yrs 1-3	(b) (6)	(b) (6)	(b) (6)	(b) (6)
Co-PI Kayla Clark Asst Lecturer	(b) (6)	0.0825 academic year, Yrs 1-3	(b) (6)	(b) (6)	(b) (6)	(b) (6)
Ph.D. student	(b) (6)	Full GA stipend (3 years)	(b) (6)	(b) (6)	(b) (6)	(b) (6)
Technician 1	(b) (6)	0.25 academic year, Yrs 1-3	(b) (6)	(b) (6)	(b) (6)	(b) (6)
Total Personnel			$51,020	$52,551	$54,127	$157,698

*For those with 9-month contracts, 12-month annual effort salaries and effort calculations include academic year salary + 33% salary for maximum allowed summer effort.

B. Fringe Benefits Fringe rates are 36.6% for faculty, 44% for staff and 2.4% for students. Students receive FICA, worker's comp, and unemployment insurance.

Position/Title	Yr1	Yr2	Yr3	TOTAL
PI Hochard, Asst Prof	(b) (6)	(b) (6)	(b) (6)	(b) (6)
Co-PI Kayla Clark, Asst Lecturer	(b) (6)	(b) (6)	(b) (6)	(b) (6)
Ph.D. student	(b) (6)	(b) (6)	(b) (6)	(b) (6)
Technician 1	(b) (6)	(b) (6)	(b) (6)	(b) (6)
TOTALS	**$11,411.00**	**$11,753.00**	**$12,105.00**	**$35,269.00**

C. Travel (Faculty) – Domestic: Total = $2,400

Purpose of Travel	Location	Item	Computation	Cost Yr1	Cost Yr2	Cost Yr3	TOTAL
Annual conference presentations	TBA	Lodging	1 person x $93 per night x 4 nights	$372	$0	$372	$744
		Airfare	1 person x $624 round trip	$624	$0	$624	$1248
		Per diem	1 person x $51 per day x 4 days	$204	$0	$204	$408
Subtotal				**$1,200**	**$0**	**$1,200**	**$2,400**

D. Equipment – N/A

E. Supplies Total: $7,000

1. Computer supplies: $7,000 is requested in Year 1 of the project for desktop terminals with sufficient processing power for the econometric and machine learning analysis and external, back-up hard drive storage (2 Dell Workstations $4,500; 8TB External Solid-State Hard Drives with Redundancy $1,400; 2 additional monitors $400; Upgraded RAM, Video Card and Cooling $550; USB drives $150).

F. Contractual: N/A

G. Construction: N/A

H. Other: $29,079 Tuition Total: Graduate Student tuition remission is requested each year and increases by 3% annually: $9,408 in YR1, $9,690 in YR2 and $9,981 in Yr3. Educational supplies: $1,500 is requested in each year for the mailing of community engagement reports.

$449,700 Subawards Total: Subawards will be issued to The Citadel and East Carolina University.

Other Expenses	**Cost Yr1**	**Cost Yr2**	**Cost Yr3**	**Total**
Tuition (U Wyoming)	$9,408	$9,690	$9,981	$29,079
Educational supplies	$1,500	$1,500	$1,500	$4,500
Subaward Institution	**Cost Yr1**	**Cost Yr2**	**Cost Yr3**	**Total**
The Citadel	$14,824	$15,269	$15,728	$45,821
East Carolina University	$131,869	$134,131	$137,879	$403,879
Total Subawards	**$146,693**	**$149,400**	**$153,607**	**$449,700**
Total Other	**$157,601**	**$160,590**	**$165,088**	**$483,279**

East Carolina University requests partial summer support for four faculty members and funding for a research technician and two undergraduate students. In addition, funding for supplies, travel and private well water testing fees are requested. East Carolina University will lead statewide soil mapping an hydrological modeling for the state of North Carolina while facilitating private well water testing through county public health contractors in North

Carolina. The Citadel requests partial summer support for one faculty member to lead the synthesis of historical and spatially-explicit precipitation and temperature data into the econometric modeling of well contamination risk.

I. **Indirect costs:** $114,306 Total indirect costs have been assessed at 44.5% of modified total direct costs (exempt: tuition remission). Indirect costs have been assessed at 44.5% of a modified total direct cost base in compliance with the federally negotiated rate for the University of Wyoming and up to $25,000 on subaward direct costs.

BUDGET INFORMATION - Non-Construction Programs

OMB Number: 4040-0006
Expiration Date: 02/28/2022

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. EPA-G2019-STAR-E1	66.509	$	$	$ 799,952.00	$	$ 799,952.00
2.						
3.						
4.						
5. Totals		$	$	$ 799,952.00	$	$ 799,952.00

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY				Total
	(1)	(2)	(3)	(4)	(5)
	EPA-G2019-STAR-E1				
a. Personnel	$ 51,020.00	$ 52,551.00	$ 54,127.00	$	$ 157,698.00
b. Fringe Benefits	11,411.00	11,753.00	12,105.00		35,269.00
c. Travel	1,200.00	0.00	1,200.00		2,400.00
d. Equipment	0.00	0.00	0.00		0.00
e. Supplies	7,000.00	0.00	0.00		7,000.00
f. Contractual	0.00	0.00	0.00		0.00
g. Construction	0.00	0.00	0.00		0.00
h. Other	157,601.00	160,590.00	165,088.00		483,279.00
i. Total Direct Charges (sum of 6a-6h)	228,232.00	224,894.00	232,520.00		$ 685,646.00
j. Indirect Charges	49,820.00	33,811.00	30,675.00		$ 114,306.00
k. TOTALS (sum of 6i and 6j)	$ 278,052.00	$ 258,705.00	$ 263,195.00	$	$ 799,952.00
7. Program Income	$	$	$	$	$

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SECTION C - NON-FEDERAL RESOURCES

(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e)TOTALS
8. EPA-G2019-STAR-E1	$	$	$	$
9.				
10.				
11.				
12. TOTAL (sum of lines 8-11)	$	$	$	$

SECTION D - FORECASTED CASH NEEDS

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	$ 278,052.00	$ 69,513.00	$ 69,513.00	$ 69,513.00	$ 69,513.00
14. Non-Federal	$				
15. TOTAL (sum of lines 13 and 14)	$ 278,052.00	$ 69,513.00	$ 69,513.00	$ 69,513.00	$ 69,513.00

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT

(a) Grant Program	FUTURE FUNDING PERIODS (YEARS) (b)First	(c) Second	(d) Third	(e) Fourth
16. EPA-G2019-STAR-E1	$ 278,052.00	$ 258,705.00	$ 263,195.00	$
17.				
18.				
19.				
20. TOTAL (sum of lines 16 - 19)	$ 278,052.00	$ 258,705.00	$ 263,195.00	$

SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges: 685,646

22. Indirect Charges: 114,306

23. Remarks: Indirect costs at federally negotiated rate of 44.5%